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NITRA

AN OVERVIEW OF ENERGY CONSERVATION IN TEXTILE MILLS

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Indian textile industry has undergone tremendous change during the last several years due to Govt.'s liberalised industrial policy towards globalisation and open economy. There has been a considerable boost to export-import activity.

Many EOU's are being set-up; a lot many old units are either modernised or being closed down. There has been a trend of more & more of spinning, spinning-dyeing, processing, knitting units coming up. Many garments units are also being opened. In order to increase exports especially to Europe & USA many textile mills are taking up ISO-9000 quality management systems for improving total quality system in the mill. It is very essential that mills should produce good quality products consistently at a much competitive cost in order to compete with other countries like China, Korea, Pakistan etc. Market condition inside India has also undergone change. Competition among various groups has increased. Also imported goods are coming in the market at a

lower cost. Similarly majority of cloth is being made by the decentralised sector i.e. Powerloom at a much cheaper cost. so the mills in the organised sector are finding lot of difficulty in healthy survival. So in order to sell their products in the market they have to maintain a lower cost keeping the quality factor in mind.

Energy cost component is next only to salary & wages. Energy cost is expected to rise much faster due to crisis in the energy sector. Most important aspect in planning the energy system is not only the cost of energy but availability & quality also. Eventually all the above factors contribute to the overall energy cost which is not generally taken into account by the management during the planning stage. So it will be quite rewarding if proper selection of energy systems is done at the beginning. It will be much cheaper in the long run.

POWER SOURCE-PURCHASED OR GENERATED?

Now a days purchased power is becoming costlier than generated power; U.P it has already become. So it would be wise in the long run to install cogeneration system during the initial state for those mills who are using steam & power both.

For smaller range (1 to 5 MW) cogeneration with DG set is most suitable. As shown in Table this proposal is quite attractive. The whole project may be paid back within 2 years.

For the mills who are already in existence, conversion to cogeneration with existing DG sets may be equally beneficial. If the mill has DG sets of over 500 KVA capacity this may be converted to cogeneration system. (if there is both *** of steam & power). DG sets must be thoroughly repaired before being put into continuous operation and of course at least one set must be kept as stand-by.

Depending on the cogeneration capacity, a portion of total installed power may be surrendered to the State Electricity Board. Depending on the situation, mill may opt for full cogeneration or part cogeneration. The latter has the advantage in the sense that there will be flexibility of both own generation and outside available power-in case of problem on one side the other may help. The savings due to cogeneration is shown in the Table. The differential fuel saving (on the basis

of power cost in U.P) has been shown as Rs. 45/- lakhs per year. Apart from saving of fuel, the saving due to reduction in differential cost of electricity has been estimated as Rs. 1.89 lakhs per year in a medium sized spinning-cum-processing unit. Side by side there are additional intangible benefit of improved quality due to continuous power supply to the machines and reduction in production loss due to power problems (which is difficult to quantify but definitely it will substantial saving).

POWER DISTRIBUTION & CONTROL SYSTEM:

Lot of development has taken place in the distribution side. High efficiency foil wound transformer having low losses, low size with superior designs are being used widely. AVR's having accurate voltage control (+ 2%) can be installed in separate feeders to minimise voltage fluctuation problems which are vital for some machines like OE, Airjet spinning, Preparatory & Electronic panels etc.

MD controllers and PF controllers are being used widely for achieving saving of power cost and system efficiency improvement.

DRIVES & CONTROL :

Today is the age of drives and control ; lot of innovation has taken place in this area - Inverter drives of different types. There are several vendors each claiming his is the best in terms

of energy saving and speed variation. Recently many of these drives have entered textile industry also. NITRA has taken studies on some of these drives.

Most promising of them are Advanced Variable Speed Drive (AVS) developed by Crompton Greaves. This drive adopts simplicity of AC motor with performance of DC motors. Near Unity power factor of all loads & speeds. Contimum full torque even at zero speed 100:1 speed range as standard & 2000:1 speed range with servo option. High efficiency. It has a wide application in industry for different types of machines.

AIR CONDITIONING & HUMIDIFICATION

Inverters are also being used in Humidification system for energy saving. Modern humidification system has automatic controls to control the dampers of both fans & pump. Rotary filters have revolutionised the humidification system. There are very efficient, fool proof, automatic and highly productive. In A/c conventional vapour compression is replaced by Vapour Absorption System. Freon refrigerants which are toxic are being replaced by eco-friendly refrigerants like Chloro Fluro Carbon etc.

HIGH EFFICIENCY MOTORS

Motor design has undergone tremendous change. Today motors are available which can give around 3 to 5% higher efficiency. Side

by side selection of right type of motors running at right load has become all the more important. A proper maintenance system can minimise motor burning.

ILLUMINATION:

NITRA experience shows that there is lot of variation in mill lighting level-4% to 10% of total average power consumption. There exists lot of scope of energy savings.

Following steps should be taken for this:

* Proper design.
* Replacement of 40 watts fluorescent tubes by 36 watts tubes.
* Replacement of conventional chokes by new electronic/other chokes
* To install voltage stabiliser on main lighting system with constant output of 380 volts.
* Automatic lighting control system.
* Use of sodium vapour lamp for savings and long life.
* Use of solar lighting acrylic sheets in day time.
* Cleaning & maintenance of reflectors.
* To stop use of Tungsten Filament lamp & conversion from incandescent to compact fluorescent lamp which are available in 9 W & 11W sizes.

MACHINERY DEVELOPMENT

Due to liberalised export-import policy of the government, Indian textile industry is fast modernising by importing textile machines of different types. Indigenous machinery manufacturers are also either developing or assembling modern machines which are already used by our industry. These machines are high productive having automation starting from chute fed blowroom lines, high speed cards, Draw Frames with auto-levellers, high capacity Ring Frames, TFO's Autoconers, Open-end machines, Murata Airjet Spinning, Automatic shuttle-less weaving, etc. These require high degree of maintenance system. These machines consume more power but are energy efficient in the sense that if utilised at the most optimum level, they can improve the specific energy consumption index.

In the textile processing area, lot of developments have taken place.

Starting from high efficiency steam generation boilers like coalfired FBC boilers (efficiency level more than 80% with any type of fuels), there are high efficiency oil-fired packaged boiler (efficiency level more than 82%). Automatic "Softflow" type processing machines are being used where scouring, bleaching, washing, dyeing, soaping etc. operation are carried

out in sequence order through computerised control panel. One has to set the programme only and the set operations will be automatically done.

EFFICIENT DRIERS & STENTERS:

Highly efficient driers and stenters are being used which has recirculating gas system with automatic feed control, heat control system etc.

Radio-frequency Driers are also being widely used by many mills which does not need steam or heat for drying but high frequency waves are being generated for dying. This new technology is highly energy efficient but initial investment is quite high. In this, quality of drying is also very good & highly productive.

HEAT EXCHANGERS

Lot of process heat is wasted by way of hot effluents which are simply thrown away. Suitable design of heat exchangers can recover lot of waste heat from process effluent. Similarly in furnance hot gases at high temperature are released. Specially designed heat exchangers can recover lot of heat, saving precions fuel.

NON-CONVENTIONAL ENERGY:

World-wide R&D work is going on to develop feasible non-conventional energy sources. But till today no cheaper alternative is available. But some developments in the field of solar energy hot water heating is available. Some parties have come forward to install this technology on soft loan basis. No doubt this has long-term benefit since fuel cost is going to increase exponentially.

Similarly Bio-mass fuel like rice-husk is being used as replacement to coal in FBC boilers. Bio-mass gas is also being generated for use in small uses. For example those mills who produce willow dust from cotton spinning can opt for cotton willow-gas for use in canteen or gas singeing etc.

INSTRUMENTATION & CONTROL

Tremendous advancement has taken place in instrumentation & control. Electronic energy meters, Load manager, MD controllers, Computerised load management system, Boiler controllers, Automatic steam valves, PF controllers, Steam flow meters, recorders & controllers, Humidification controllers, etc. are being used to effectively control energy consumption. It is suggested that mills should procure these instruments.

DEVELOPMENT IN LUBRICATION SYSTEM:

Lot of developments have taken place in lubrication area. Recently IOC have developed synthetic based oils having more useful life and giving energy saving. High temperature greases have also been developed.

High efficient & longer duration engine oils have also been developed.

Proper application of lubrication with right system of storage & handling will help in conserving this valuable resource.

CONCLUSION

In order to implement energy conservation measures in a proper manner so that it is result oriented, it is essential that management constitutes a "Energy Cell" with members from each department & headed by chief of the unit. They should make an action plan & monitor it regularly.

Next important aspect is the imparting of proper training to middle & lower level of people.

We in NITRA are providing consultancy & training in Energy Management for the last 15 years & have been approved by Ministry of Energy & IDBI. Being a non-profit making Govt. Aided body our charges are nominal & we see that our services are result oriented.

ENERGY EFFICIENCY IMPROVEMENT THROUGH CO-GENERATION

Techno-economics for a spinning mill having 25,000 to 30,000 spindles

Maximum load : 3.5 MW

Monthly electricity consumption : 21.0 lakhs kWH or

Monthly specific power consumption (Units/Spdl./Shift) = 0.78 to 0.93

Hydel supply installation with transformer cost	Cost of co-generation with own generation system	Cost of D.G. Unit	Overall cost of Hydel Units	Steam generation per MW of DG set	Monthly Total D.G.cost @ Rs. 2.5/kWH for 21 lakh kWH	Monthly Hydel electricity charges @ Rs. 3.25/kWH for 21 lakh kWH	Monthly steam generation @ 0.5 Ton/ MW of D.G.	Rate of Steam
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.0-1.25 crores	2.0-2.5 crores	Rs. 2.5 per kWH	Rs. 3.25 per kWH	0.5 Ton/Hr	52.5 lakhs	68.25 lakhs	1260 Tons	Rs. 300/-

Annual Cost Saving through steam generation	Annual Cost saving in electricity	Total cost saving	Total excess initial investment	Payback period at 100% load	Payback period at 80% load
(10)	(11) (7-6) x 12	(12) (10 + 11)	(13) (2-1)	(14)	(15)
45.36 lakhs	1.89 crores	2.34 crores	1.25 crores	6.4 months	8.0 months

Plant Maintenance Management in Textile Industry

PLANT MAINTENANCE MANAGEMENT
IN TEXTILE INDUSTRY

1.0 INTRODUCTION

Textile Industries are energy and capital intensive. The process also involves hazardous conditions and risk to plant, personnel and public. Proper Maintenance Management has been observed as one of the important elements towards overall improvement of the textile industry, specifically in terms of energy and environment effectiveness. It has been observed from performance parameters that maintenance productivity has direct relation to energy consumption and also environment performance. This article describes the latest developments in plant maintenance management that can play stellar role in energy and environment management of Textile Industries.

2.0 ROLE OF MAINTENANCE IN ENERGY CONSERVATION & ENVIRONMENT PRESERVATION

Conservation of energy and compliance with environmental regulations have become increasingly important due to steep increase in energy consumption & environmental pollution as the indutries are going in for large scale capacity expansion and modernisation. Apparently, it is being felt that it is the responsibility of the top management. But, it depends much on how effectively the plant is operated and maintained and hence it is the Operation & Maintenance Departments who can substantially contribute to energy conservation and environment preservation.Often "Maintenance" is overlooked as "*Necessary Evil*" and is considered as *Consumable rather than Producible* as there is a firm belief that maintenance costs money. But maintenance not carried out costs even more money. Proper planning and appropriate maintenance strategy can lead to increased capacity utilization & substantial savings. The key words for improving Total Systems Performance of a Textile Unit namely, Production, Energy Consumption, Quality, Delivery, Safety & Environment, Cost and Morale have a very close relation with maintenance of the plant.

3.0 EFFECTIVE MAINTENANCE MANAGEMENT STRATEGIES IN TEXTILE INDUSTRIES

The development in maintenance management has been based on technological advancements from conventional Breakdown Maintenance to Preventive Maintenance, Predictive Maintenance, and Proactive Maintenance Strategies. Different management theories like Reliability Based Maintenance and Total Productive Maintenance (TPM) approach the selection and utilization of these technologies from different perspectives.

Breakdown Maintenance is possibly the weakest strategy as it is bound to increase down time, energy consumption, production loss, machine/component replacement and also may be the root cause of many safety and environmental disasters. Due to these deficiencies, it is possibly the last choice of a maintenance management function, however still practised many a times rather by compulsion due to many limitations. While it may not be possible to completely eliminate

breakdown maintenance, it would be prudent to limit it to applications where the consequence of failure would be negligible for plant availability, energy loss and environment & safety.

Preventive maintenance is widely being practiced now-a-days in Textile Industry. Preventive maintenance emphasizes on carrying out periodically scheduled activities on the equipment either to avoid the breakdowns or identify the condition well before it can turn into a breakdown. For example, simple preventive maintenance activity like regular cleaning of motors can give rise to considerable savings in heat losses and also failure of motor windings. Rolling element bearings in power looms, ID fans or Pumps Compressors would be changed, irrespective of whether they are damaged or not. Similarly, lubricating oil in the gear boxes would be changed after a predetermined period of working hours. However even preventive maintenance strategy has pitfalls that it is not easy to decide upon such intervals of inspection and replacement. Too frequent Preventive Maintenance activities lead to wastage of production time as well as unnecessary replacement of machine parts and components. Moreover, there is always possibility of human error while performing such inspections and maintenance work and the material consumption may be more than ideal or the human intervention in the equipment technology may aggravate the failure rates rather than obviate it.

Predictive maintenance using Condition Monitoring Techniques can to a large extent, solve the deficiencies of both breakdown and preventive maintenance strategies. Even indirect preventive maintenance, known as subjective condition monitoring using human senses, would be able to identify failures in advance and aid in taking corrective action. Both simple aids and instrumentation enhance the predictive maintenance capabilities to solve many equipment failures, energy losses, environment and safety problems.

Proactive maintenance strategy advances over the predictive maintenance technology in its ability to identify machinery deviation even before it begins to develop. The ability of some monitoring instrumentation to track the hydraulic oil contamination even at the ppm trace levels and eliminate them using cleaning equipment simultaneously is an example of proactive maintenance strategy.

4.0 PREDICTIVE MAINTENANCE & CONDITION MONITORING

Predictive Maintenance is carrying out preventive maintenance at what may be irregular intervals, but determining these intervals by the actual condition of the machine. For such condition-based maintenance to be possible, it is essential to have knowledge of the machine condition and its rate of change with time. The main function of condition monitoring is to provide this knowledge. The knowledge may be obtained by selecting a suitable parameter for measuring deterioration, and recording its value at intervals. Assessing the trend of this measurement can give a useful lead time in warning of incipient machine failure and in planning and organisation of maintenance work.

Condition Monitoring would be very useful in the following textile machinery:-

1. Blow Room Machines
2. Combing Machines
3. Gear Boxes
4. ID fans
5. Spinning/Weaving Macninery
6. Pumps
7. Generator Sets
8. Compressors
9. HT Motors
10. Transformers

4.1 Condition Monitoring With Simple Aids

It is wrong notion among us that for carrying out objective condition monitoring, we shall always require complicated instruments. Actually there are methods available and methods could be developed to do the same with simple aids. A few examples of using simple aids for condition monitoring in textile units are given below.

Example 1: For monitoring the temperature rise of bearings and motors, use can be made of temperature tapes. The tapes are available for different temperature bands. The tape carries windows for different temperature levels within the band. The tape is to be pasted on the surface which needs temperature monitoring. Once a particular temperature level has reached, the corresponding window changes colour, mostly black.

Example 2: V-belts drives used in various rotating machineries like pumps, compressors and blowers can be monitored for right tension using simple aids known as 'Tensiometers'. The instrument is capable of applying a predetermined displacement to the belt and quantifiably measure the force required to produce the same thus predicting whether the belt drive is having proper tension or not.

Example 3: In a flexible pin and bush type of coupling, the wear of the rubber bushes can be easily checked by marking the coupling halves. As the coupling is loaded, the marks separate. As the rubber bush wears, dimension 'A' (the distance of separation of the marks) increases. A maximum value of dimension 'A' can be set as a limit when the rubber bushes are to be replaced. Dimension 'A' can inspected when the coupling is running with the help of a stroboscope.

Example 4: To monitor the condition of lube oil in service a simple aids known as 'Viscosity comparator' and 'Moisture Test Kit' can be used. The viscosity comparator uses the principle of flow differences due viscosity variations between used oil and fresh oil. The moisture test kit finds out the percentage of moisture in the lubricating oil using chemical methods by reacting Calcium Hydride with the moisture present in the oil in a small reacting bottle. The resultant hydrogen emission is used to displace carrier fluid mostly kerosene and measuring the moisture percentages.

4.2 Condition Monitoring Using Modern Advanced Instruments

In process plants like the modern textile units, it is also required in addition to use periodic and on - line condition monitoring techniques and systems using sophisticated instrumentation to ensure optimum plant availability and personal safety. Of course, heavy damage to the high speed giant rotating machines can also be prevented by using these techniques. The different techniques and systems used in this category are explained below:

4.2.1. Vibration/Signature Analysis

This is very advanced technique and is very useful for on-line monitoring of rotating machines like diesel generators, pumps, compressors, gearboxes etc. This technique should be used for critical machines only because it is a costly technique and it requires lot of skill to interpret and analyze the readings. The characteristics used to diagnose the incipient failures and also the nature of failures

are amplitude (peak to peak displacement, velocity and acceleration) and frequency of vibration. The principle is that as failure develops, the amplitude of vibration increases and depending on nature of failure, a particular frequency of vibration is generated.

The textile industry should have an active programme involving routine noise and vibration measurement, analysis and control on important production and operating machinery to avoid unscheduled shut downs and costly failure. All machines vibrate and make noise - because of mechanical defects, large and small. Excessive vibration or a substantial increase in the normal vibration or noise level of a machine is a warning that there is a deterioration in the component function. There could be many reasons for high vibration. Some of these are:-

a. Unbalance of rotating parts
b. Misalignment of couplings and bearings
c. Mechanical looseness
d. Bad antifriction bearings
e. Bent shafts
f. Worn, eccentric or damaged gears
g. Bad drive belts and drive chains
h. Hydrodynamic forces in case of Pumps
i. Aerodynamic forces in case of Fans
j. Electromagnetic forces
k. Oil whirl

A lot can be learned about a machine's condition and mechanical problems by simply noting its vibration characteristics in terms of frequency, displacement, velocity, acceleration and phase. When analysing a machine's vibration to pinpoint a particular problem, it is essential to know the vibration frequency. Knowing the frequency allows us to identify which part is at fault and what the problem is. The displacement, velocity and acceleration characteristics of vibration are measured to determine the amount or severity of the vibration. Displacement and velocity measurements will be sufficient for majority of textile machinery. Acceleration measurement will be more relevant in case of gear boxes.

Signature Analysis

In many situation a change in the vibration of one frequency component, which is indicative of trouble, can be masked by a more dominant but acceptable vibration at another frequency. In such circumstances frequency analysis is essential. In the frequency analysis process an electrical filter network is employed to reject part of the frequency spectrum whilst allowing another part to pass through the filter. Several sophisticated vibration analysers and signature plotters are available these days. These can analyse and represent the vibration signal in terms of:-

a. Amplitude versus frequency;
b. Amplitude versus time;
c. Amplitude versus frequency versus time;
d. Amplitude and phase versus rpm.

The results of this type of analysis, presented as a plot of amplitude versus frequency etc., is referred to as the vibration signature of a machine. Interpretation can be made out of these signatures in order to find out the possible cause of high vibration. Generally, vibration signatures will be recorded soon after commissioning a new machine, when it is running satisfactorily. These signatures taken in the beginning are referred to as "baseline signatures". Future comparison of vibration readings will be made against these baseline signatures. Once a problem has been identified through analysis, the obvious next step is correction, for which many balancing and other maintenance techniques are available. In the case of gearbox problems, in addition to the spectrum analysis, cepstrum analysis would also be made use of.

Gear Box Problem Diagnosis

Vibration spectrum analysis alongwith cepstrum analysis would be an effective way of diagnosing gear box problems. The gear box spectrum will contain the meshing frequencies (the number of gear teeth times the rpm of the faulty gear), their harmonics, overtones, side bands, etc. The various problems of gear failure such as excessive gear wear, improper adjustment of backlash, gear tooth inaccuracies, faulty lubrication, gear eccentricity etc., can be detected through the Cepstrum Analysis.

4.2.2. Shock Pulse Method (SPM)

This is very useful and economically viable method to monitor operating condition of antifriction bearings. In fact this technique was developed after observing that the diagnosis of operating condition of antifriction bearings with vibration analyser is extremely difficult as the amplitude is unsteady and frequency is very high. Shock pulse method is based on the principle that when a surface defect is developed on the rolling element or the races, a mechanical shock will be generated. This shock intensity is measured with shock pulse meter in terms of dB to monitor the operating condition of antifriction bearings. A correlation is established between bearing condition and rise in shock value level (SVL) relative to the normal shock value. The interpretation of the results is quite easy and the instrument is very portable.

Rise in SVL (dBN)	Bearing condition
less than 20	Good condition
15-25	Undamaged bearing lacking lubrication or improperly installed
20-35	Damage developing
35-50	Visible damage
50-60	Rise of breakdown

An examination of the reliability of ball and roller bearings showed that their service lives differed considerably. For the purposes of the test, a number of ball bearings were utilized under identical

conditions. After a certain period of time, 10% of the bearings had broken down. However, it took twenty-five times as long for the last bearing to fail. If in the course of preventive maintenance, all ball bearings were to be replaced after a period of time when 10% of the bearings tend to fail, the potential lives of the remaining 90% would be wasted. 90% of the bearings would be replaced too soon, and yet there would be cases of unforeseen bearing failure. On the other hand, if the condition of each bearing is established during operation by continuous inspection and replacement is carried out only when it appears justified, we achieve the following advantages:

1. Fewer bearing replacements
2. Reduced bearing consumption
3. Increased operational reliability
4. Less need for planned stoppages for bearing replacements

Rolling-element bearings are used in textile machinery in greater quantities and they are one of the most common types of failure in the textile industry. The probable reasons for failure are excessive load, metallurgical failure, lack of lubrication, use of contaminant lubricants, improper mounting and the completion of the safe working life. The downtime cost is very high in case these bearings fail during operation. At the same time, we can not afford to replace these bearings at fixed intervals due to high cost.

4.2.3. Spectroscopic Oil Analysis Procedure (SOAP)

SOAP is a technique to monitor condition of machines by analysing used oil samples. It is an indirect method. The principle of this technique is that is measures concentration of wear particles of different elements present in the used oil sample with the help of a 'Direct reading spectrometer'. The wear debris will be microscopic particles forming a homogeneous colloidal suspension in oil. These particles are too small to be removed by filter. A normal wear rate may be established for a particular metal in a particular system. Any condition which increases the friction between moving parts will accelerate the wear rate and thus be detected by SOAP.

4.2.4. Ferrography

Ferrography oil analysis enables a detailed examination to be made of the microscopic particles generated by wearing surfaces and so can yield valuable information about the condition of components. The basic concept involves the magnetic separation of iron and steel (ferritic) wear debris from a lubricant and arranging it, according to particle size, on a glass slide for subsequent examination through a microscope. The particle sizes may range from sub-micron to several hundred microns. During severe wear, when failure is beginning, the deposit will change drastically, the total quantity of debris will increase, there will be a greater proportion of larger sizes and the maximum size will also increase.

4.2.5. Thermography

This technique is based on measurement of infra-red radiation emitted by different materials at different temperatures. The surface of the object to be monitored is scanned with a camera which produces a thermal pattern on a video screen corresponding to the temperature distribution. This

helps in locating the hot spots because the intensity of light at each point of the screen depends on temperature at corresponding point on the object. The greatest advantage of thermography instrument is that the hot spots can be detected from a distance without requiring any contact with the object and a big area can be scanned very fast as from maintenance point of view we need to know only the hot spots and not the absolute temperature. Thermography is very useful to identify failed refractory / insulation conditions and also electrical transmission and distribution systems like cable boxes, circuit breakers, transformer, contractors, insulators, etc. The insulation strength of high voltage motor windings can also be monitored.

The monitoring system primarily consists of a high speed infrared scanner for measurement of the infrared radiations/heat emitted from a surface, a computer for analysis of temperature readings and a graphical display screen/printer. Such a sophisticated system enables us to determine the state of lining/coating/insulations/joints etc. and location, size & geometry of existing or developing hot spots.

4.2.6. Systematic Application Of Condition Monitoring

One of the problems of condition monitoring is the state of confusion generated by the wide variety of monitoring techniques. Even within the field of vibration monitoring, there is a profusion of measurement methods each with its particular virtue. Each technique requires a special skill and understanding and some of the more useful techniques have been developed only in the last decade.

The key feature of condition monitoring, whatever the technique in use, is the accumulation of data, which at the time of collection seem to have limited value, however, only when sufficient data are collected can normal condition and possible deviations be established and redundant data cease to be accumulated. Thus keeping records is essential to any monitoring programme. To keep paper work to a minimum the data recording system should be devised to provide the important information clearly to the decision maker. Where possible the forms devised for collection of data should also serve to present the information necessary for decision making so that transfer of data is avoided. For example, where the trends in a monitored parameter are used to indicate plant condition it is useful for the data to be plotted directly onto graphs since the mind can absorb visually presented data more effectively than written data. Unfortunately, in the early stages of a monitoring programme there is considerable redundancy in measurements. Only when experience of normal conditions and malfunctions has been obtained will the engineer be able to cut down on the number of measurements made. The importance of recording all relevant particulars of the machine and of the monitoring equipment and tests cannot be over emphasized. One of the most common difficulties encountered by the decision maker, when a monitoring technique detects a trend indicative of failure, is lack of data. Where many machines are operated, consideration should be given to the advantages of computer data storage and presentation.

5.0 TOTAL PRODUCTIVE MAINTENANCE (TPM)

Technology oriented developments like condition monitoring as described above alone have failed to produce desired results. It was felt that human participation is a vital element in achieving total improvements and hence led to practice of methodologies like TPM. Conceptually, TPM is

departure from the "I Operate - You Fix" approach to "I Operate and I maintain" philosophy. It is implementation of productive maintenance by all employees, based on the principle of involvement of all in improving equipment performance from operators to top management. TPM takes on the challenge of Zero losses, meaning zero failures and zero defects. When there are no failures or defects, equipment effectiveness improves, costs are reduced and stock can be reduced and hence productivity improves. In addition to the tangible effects, TPM also has intangible effects that are not represented in figures like positive work culture, improved motivation levels, dynamic and enthusiastic work force improved working conditions, clean & safer environment etc. The goal of TPM is to maximize equipment effectiveness or in other words the pursuit of economic LCC (Life Cycle Cost) of equipment/physical assets. Industries revolve around man - machine system and TPM aims at maximising the effectiveness of this man-machine system at the minimum LCC. In order to maximise the effectiveness, TPM focuses firstly on "Eliminating Big Losses In Equipment" that interfere with the effective operation of the system.

The Big Losses are:

Down Time Losses	1. Failures: Downtime losses due to unexpected breakdowns 2. Set Up & Adjustment Losses
Speed Losses	3. Idling & Minor Stoppages 4. Reduced Speed
Defect Losses	5. Defects in process 6. Reduced Yield.

Thus, as can be seen above, TPM results in Overall System Effectiveness/Overall Equipment Effectiveness (OEE) through the combination of the availability, performance efficiency and the rate of quality products. Secondly TPM emphasizes on Periodic Maintenance/Preventive Maintenance through Autonomous Maintenance/Small Group activities.

5.1 Small Group Activities in TPM

Small group activities in TPM are of the company-led type. What gave concrete form to this company led type was the overlapping organization of small groups. In general, small group activities are confined to on-the-floor workers, but in TPM an organization is built that overlaps at several levels of group of executives (TPM Promotion Committee) down to small groups of on-the-floor workers i.e. an overlapping organization of small groups. The aim is to have the leaders at each level fulfill roles of connection by acting as members of the small group of the level above, thus improving vertical and horizontal communication and unifying the top-down, company-led activities and bottom-up, small group activities.

When small group activities only involve on-the-floor workers (especially activities of independent type), they often become stereo-typed or lack vitality. In the case of TPM, however, all employees from top management down to on-the floor workers participate, each level of the organization is aware of its role and the whole company demonstrates a high level of vitality.

5.2 Autonomous maintenance activities by operators

Autonomous maintenance activities by operators are one of the main features of TPM, and are a key point in its development. Changing the lack of interest in maintenance on the part of operators, who think that "I'm the operator, and you're the maintenance man"' to developing autonomous maintenance - i.e. "autonomously maintaining the equipment one uses by oneself" - is not something that can be done overnight that it takes two to three years from when TPM is first introduced to when the introduction stage is completely implemented. This is because it takes time to change the attitudes of people.

Under this method, the equipment which one is currently operating is used for on-the-job training, and the operator gradually acquires maintenance knowledge and skills through training and implementation at each step. As he moves up through the steps, he gradually gains a willingness to implement TPM. This consists of the following seven steps.

1. Initial clean-ups
2. Measures against the causes of dust and dirt and places difficult to clean and lubricate
3. Formulation of cleaning and lubrication standards
4. Overall check-up
5. Autonomous check-up
6. Orderliness and tidiness
7. All-out autonomous management

With autonomous maintenance activities through this step method, the workers and equipment improve as the steps are completed. Splendid results are obtained, including the elimination of the six big losses, improved overall equipment effectiveness and the creation of a pleasant workplace.

5.3 Steps in evolving TPM program

The program for developing TPM is divided into twelve steps, from the preparatory stage through the stages of commencement and implementation right up until it has been firmly established.

Step 1 : Announcement by the top management of the decision to introduce TPM: The outcome of TPM depends on the top management itself to firmly resolve to introduce TPM and then announcing this intention to all the employees.

Step 2: Education and campaign on the introduction of TPM; Together with carrying out training at each level so that all employees, from the top down to on-the-floor workers, can correctly understand TPM, a campaign through poster slogans and so on is carried out and an atmosphere for commencing TPM, is built up.

Step 3: Creation of organizations to promote TPM : Creation of such organizations as a company-wide promotion committee, department promotion committees and special working groups for each theme, and the establishment of a TPM promotion secretariat.

Step 4 : Establishment of basic policies and goals of TPM. Survey of the actual situation of overall equipment effectiveness and the six big losses and the establishment of goals and forecast of expected results.

Step 5 : Formulation of a master plan for evolving TPM; Drawing up a schedule for each of the activities that form the pillars in evolving TPM, from preparations for its introduction up to being assessed. Once these various preparations are completed TPM is "kicked off" - i.e. the commencement of its introduction - in Step 6.

The stages of introducing and implementing TPM (Steps 7-11) are the "five activities that form the pillar in evolving TPM" that were described earlier. "Step 7 : Improvement of the effectiveness of each piece of equipment" and "Step 8 : Formation of an autonomous maintenance setup" are commenced immediately after kick-off. When autonomous maintenance activities first begin, the maintenance department shall be very bust backing up the operation section. According "Step 9 : Creation of a planned maintenance set up in the maintenance department" and "Step 10 : Training to improve operation and maintenance skills" commence at least six months after kick-off. It is effective to commence "Step 11: Creation of a setup for the initial management of equipment" after information has been accumulated on the points of disorder in the reliability and maintainability of equipment currently in operation.

Once TPM is firmly established - i.e. "Step 12 : Perfection in implementation and increased TPM level" - the company continues to challenge ever higher targets.

6.0 SAFETY AND ENVIRONMENT IMPROVEMENT

Maintenance management is nowadays inseparably linked with modern safety and environment improvement techniques. Many of the accidents have been correlated to improper operation and maintenance of the plant and equipment. Accident investigation reports have pointed out the necessity to involve plant maintenance functionaries in the initial stages of design and procurement of the equipment and also safety enhancement techniques like Risk identification and assessment. Modern risk assessment techniques like HAZOP & HAZAN come in handy for identification and assessment of risk to the man, machine and environment. The basic nature of hazard in textile industries can be classified namely: Dust Hazard, Chemical Hazard and Noise Pollution. Effective safety management and pollution control programme will minimise the risks from these hazards.

6.1 Environmental Monitoring

Environmental monitoring is carried out for several purposes, i.e. to check compliance with occupational exposure limits or standards, to test the efficiency of control measures at the workplace (e.g. the exhaust ventilation system) and to assess exposure risks of the workers in combination with other epidemiological studies.

6.1.1 Dusts and chemicals

Air Sampling: The basic principle in the sampling of airborne dusts or toxic chemicals is to draw in a known volume of air through an entraining device (e.g. a filter paper, a solvent in which the

substance to be sampled is soluble or an absorbing substance like activated charcoal that absorbs toxic vapours being sampled). The collected sample is weighed and the results are measured gravimetrically or determined chemically and expressed in mg/m^3 or parts per million (ppm). In some instances, for example in measuring asbestos fibre concentrations in the air the individual fibres collected are counted under the microscope and expressed in fibres/ml.
The purpose of these tests is to check whether the workers are exposed to airborne concentrations of toxic substances above the occupational exposure limit values recommended in the country. Occupational Safety and Health Series No.37 gives the occupational exposure limit values adopted in a number of countries.

The results of environmental monitoring programmes may indicate the need for corrective measures to improve the working environment. Considering the number of toxic substances to which workers in the textiles industry may be exposed, it is important to establish lists of occupational exposure limits and set up enforcement machinery capable of checking compliance with the exposure limits.

6.1.2 Noise

The basic noise measuring instrument is the noise level meter, which consists of a microphone, an amplifier and an indicating meter. The microphone responds to sound pressure by generating an electrical signal which is amplified as shown on the dial. The noise level is indicated on a logarithmic scale known as the decibel (dB) scale. In recording occupational exposure limit values the dB scale is weighted to correspond to the reception of the human ear and the values are, therefore, expressed in dB(A). As the noise-induced hearing impairment is related to the frequency of noise to which a worker had been exposed, frequency analysis is also made using frequency analysers. The ILO code of practice on protection of workers against noise and vibrations in the working environment has recommended exposure limit values: namely, a warning limit value of 85 dB (A) and a danger limit value of 90 dB (A) for an eight-hour daily exposure.

6.2 Biological Monitoring

A combined environmental and biological monitoring studies are of particular relevance to the textiles industry. Air sampling is made to measure the airborne concentrations of toxic substances in the working environment. However, many toxic chemical substances can be absorbed through the intact skin. Therefore, assessment of toxic substances or their metabolites in the biological fluids (blood and urine) is essential for determining the exposure to risk.

Moreover, exposure limits are expressed in time-weighted average concentrations, the exposure to which is believed not to have an adverse effect on the average worker. In a working population, however, there are persons who may be especially susceptible to a toxic dust or chemical at concentrations below the exposure limit. The age, sex, workload, level of nutrition, duration of exposure, existence of non-occupational diseases and health status may all contribute to this susceptibility at lower levels of exposure. Biological monitoring is therefore necessary to detect these cases and prevent further exposure.

Exposure to vegetable dust poses other problems. For example, in byssinosis there are specific physical signs or x-ray changes. Therefore, exposure to vegetable and other cotton byssinogenic type of dusts is assessed by the decrement in lung function. The common lung function tests include the measurement of forced expiratory volume over one second (FEV) and the forced vital capacity (FVC). Smoking history is also recorded since it has a direct bearing on lung function.

6.3 Environmental Control

Ideally, environmental control should result in eliminating the hazard, whether it be a dangerous situation or condition (e.g. unguarded machinery), exposure to toxic substances or hazardous physical agents. In practice, however, this is not always possible since such industrial processes as textile processing are inherently dusty. Therefore, the next best practicable means is to substitute safer for dangerous machinery or harmless or less toxic for more toxic substances.

Substitution has been practised to some extent in the textiles industry. Perhaps, the best examples are the substitution of less toxic substances for highly carcinogenic substances (e.g. benzidine and beta-naphthylamine containing dyes and blue-asbestos); and the use of safer machinery with electronic devices to cut off power in case of imminent danger.

When substitution alone is insufficient to provide adequate protection to workers, engineering control measures have to be taken. In the textiles industry these include the provision and maintenance of exhaust ventilation systems; proper installation of noisy machines to prevent transmission of noise and vibration through materials and other devices (noise absorbers and damping to reduce reverberations); measures to reduce excess humidity (particularly in tropical climates); and improved guarding of machinery.

In additon, various other technical measures for fire prevention and work in dangerous areas have to be taken. Good housekeeping is particularly important in the cotton textile industry (e.g. removal of accumulated dust by vacuum cleaning).

6.4 Risk Analysis

Risk Analysis begins with the identification of the principal hazards which are normally fire, explosion and toxic release and then evaluating the identified risks quantitatively. With the growing complexity of the process plants, more systematic and searching methods for risk identification and quantification have been developed over the years and the latest techniques being HAZOP & HAZAN.

The methodology adopted to carry out the study on "Risk Analysis" basically involves:

- Identification of hazards/risks through HAZOP and/or a "Safety Audit".
- Analysis of the risks identified.
- Quantification of the major risks in terms of their probability of occurrence and their consequences.

6.4.1 Risk Identification

The identification of areas of vulnerability and specific hazards is of fundamental importance in Risk Assessment techniques. The different techniques used for risk identification are:

Hazard and Operability Study (HAZOP)	Hazard Indices
Safety Audits	Checklists
Screening for hazardous chemicals	Feedback from workforce.

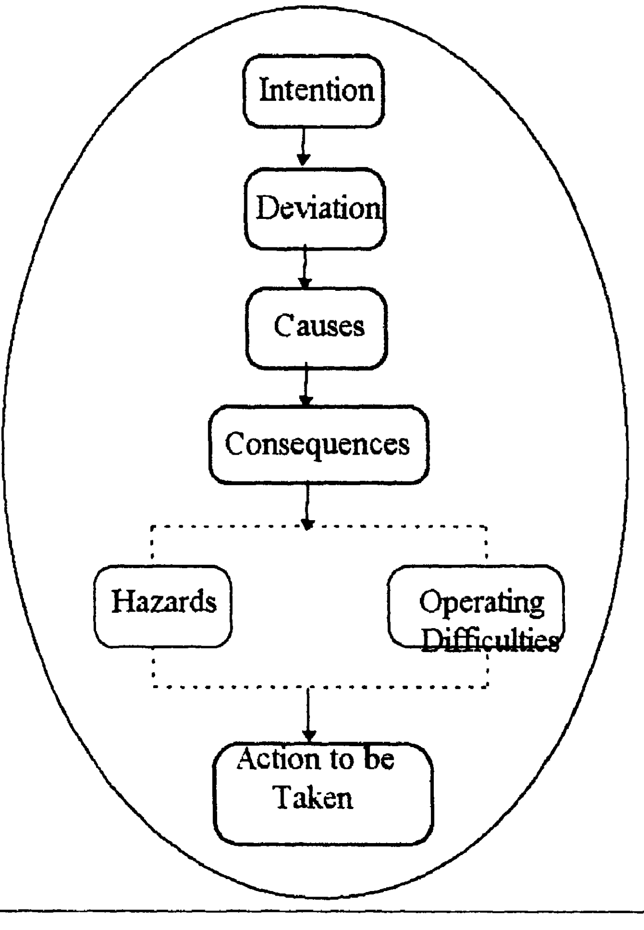
Depending on the nature of industries, their processes, chemicals handled, operational conditions etc., one or combinations of the above techniques is used for risk identification.

6.4.1 (a) Hazop Study

The latest technique for the hazard identification is the Hazard & Operability study (HAZOP). The basic concept of HAZOP is to take a full description of the process and to question every part of it to discover what deviations from the intention of the design can occur and what their causes and consequences may be. It is done systematically by applying the following guide words:

None	*Less Of*	*Reverse*	*As Well As*
More Of	*Part Of*	*Other Than*	

HAZOP - THE 5 STEPS



6.4.1 (b) Safety Audit

A safety audit examines and assesses the standards of all facets of a particular activity in detail. It extends from complex technical operations and emergency procedures to clearance certificates, job description and housekeeping etc. In general a safety audit has the following five main elements:

1. Identification of possible loss producing situations.
2. Assessment of potential loss associated with these risks.
3. Selection of measures to minimize losses.
4. Implementation of these measures within the organization.
5. Monitoring of the changes.

6.4.2 Risk Quantification

For an effective hazard control, the impact of the identified risks are to be quantified in terms of fire or explosion effects, toxic dispersion, vapor cloud hazards, flame jet lengths, heat radiation effects and their probability of occurrence. Risk quantification provides a relative measure of the likelihood and severity of various possible hazardous events and enable the emergency plan to focus on the greatest potential risks. As a result of risk quantification the hazards can be ranked as **high risk** (high probability and severe consequences), **moderate risk** (high probability and mild consequences or low probability with severe consequences) and **low risk** (low probability and mild consequences). The following techniques are used for evaluating the hazards:

1. Fault Tree Analysis
2. Consequence Analysis

6.4.2 (a) Fault Tree Analysis

Fault tree analysis is a particular application of formalized deductive logic for system safety and reliability analysis. It visually depicts the inter-relationship of component states or combinations of component states that can result in the occurrence of a specified undesired system state (e.g. total system failure or plant hazard) defined as the top event of the fault tree. Having established this inter-relationship the frequency for the undesired system state can then be predicted by assigning frequencies/probabilities for the existence of each component state or combination of component states capable of leading to the top event and processing the numerical inputs mathematically.

Thus Fault tree is constructed in two stages: First the construction of Fault Tree logic which necessitates thorough knowledge of the system or plant under examination. Secondly determination of the qualitative and quantitative implications of the completed Fault Tree which requires information on the expected frequencies/probabilities of the specified component states or events as already indicated.

6.4.2 (b) Consequence Analysis

Consequence Analysis is carried out to determine the consequences of a potential major accident on the installation, the workers, neighbourhood and the environment. It contains :

a) Description of the potential accident e.g. tank rupture, rupture of a pipe, failure of a safety valve, fire etc.

b) An estimation of the quantity of material released (toxic, flammable, explosive)

c) A calculation of the dispersion of the material released (gas or evaporating liquid)

d) An assessment of the harmful effects (toxic, heat, radiation, blast waves etc.)

6.5 Disaster/Emergency Management

An emergency incident can cause major industrial disasters involving innumerable loss of human lives, plant & property and ecological damage. Hence, it is imperative that the management of emergency is well pre-planned and documented. In its absence, often confusion results and there is precious loss of response time which may result in magnified effects of the incident. The Government of India through its recent legislation has made the preparation of Emergency Plans mandatory for the units involved in manufacturing, storage and processing of hazardous chemicals like the textile industries.

7.0 CONCLUSIONS

The combination of judicious use of the maintenance strategies, predictive maintenance techniques, human participation in maintenance like TPM and modern safety and environment enhancement techniques have been discussed above as the basis of plant maintenance management. It is envisaged that an integrated approach for the implementation of them would lead to greater performance in availability, energy efficiency, safety and environment improvement in textile industries.

Pinch Analysis in for Waste Water Minimisation in Textile Industry

M O Garg
KTI

PRESENTATION OVERVIEW

- INTRODUCTION TO WATER PINCH TECHNOLOGY FOR WASTE WATER MINIMISATION
- CASE STUDIES
- CONCLUSIONS

INTRODUCTION TO WATER PINCH TECHNOLOGY FOR WASTE WATER MINIMISATION

WHY WASTEWATER MINIMISATION ?

IN THE PAST

IT WAS ASSUMED THAT WATER IS AVAILABLE ABUNDANTLY AND LOW COST COMMODITY

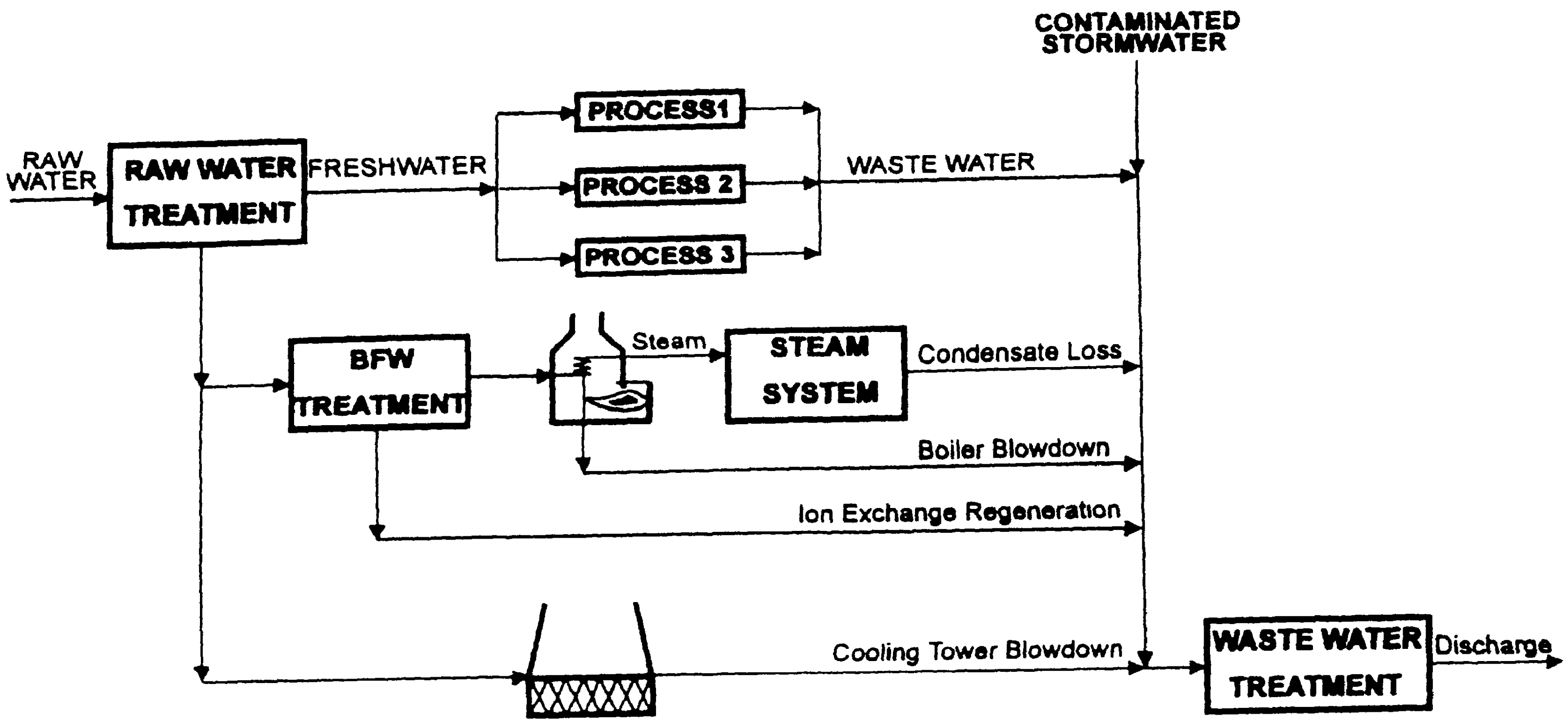
BUT NOW . . .

- WATER SOURCES ARE DIMINISHING
- FRESH WATER COST IS INCREASING
- DISCHARGE REGULATIONS ARE STRICTER
- TREATMENT COSTS ARE INCREASING

KTI

A MANNESMANN COMPANY

A typical site having many uses of freshwater and sources of wastewater



EFFLUENT CHARACTERIZED BY

- **VOLUME**

  m3/hr of water

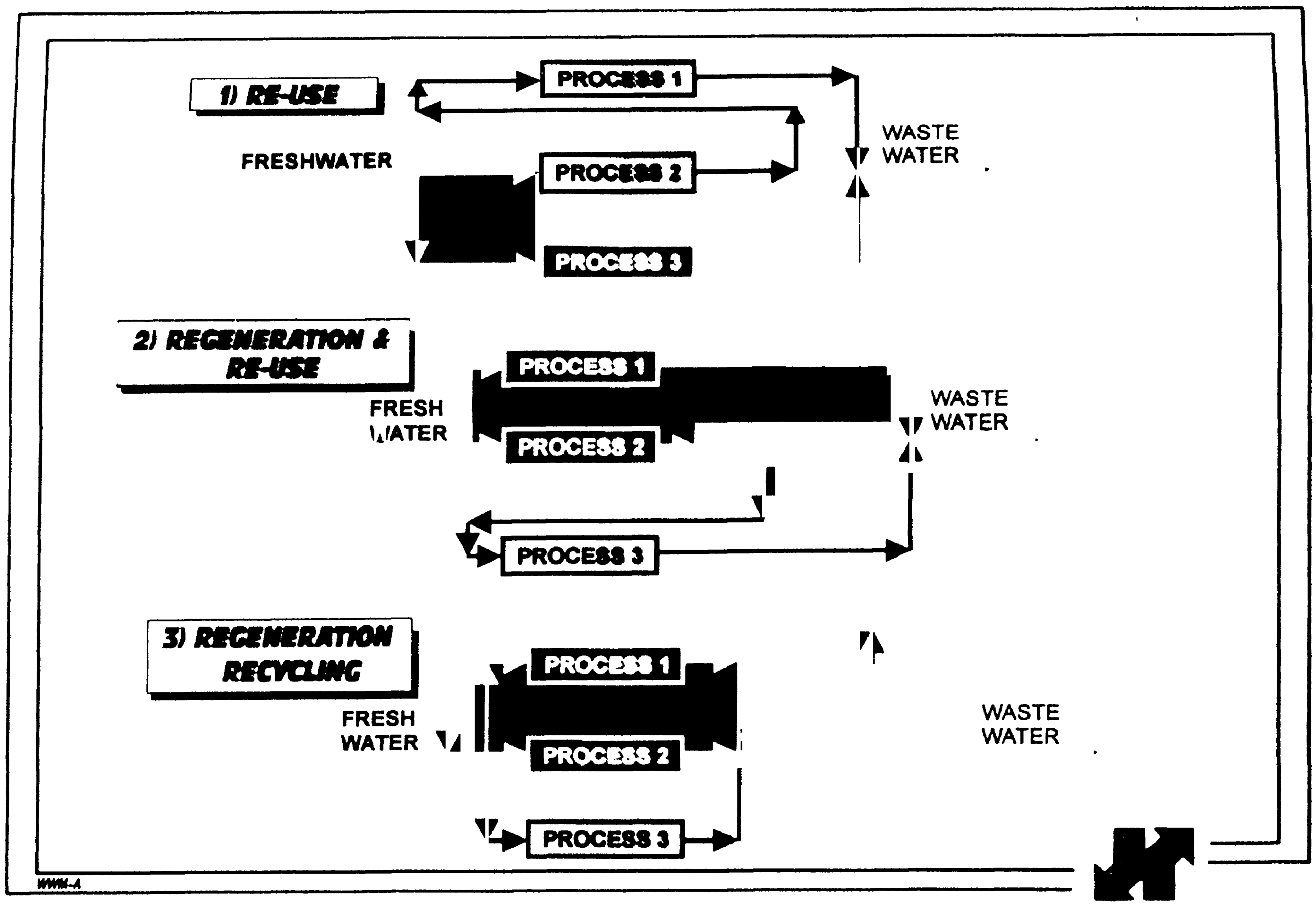
- **LOAD**

  kg/hr of pollutants carried by the water

How can we reduce both the volume and the load without making any fundamental change to the processes ?

OPTIONS AVAILABLE

- SOURCE REDUCTION
- REUSE & RECYCLE
- TREATMENT
- SAFE DISPOSAL


1) RE-USE
FRESHWATER
PROCESS 1
PROCESS 2
PROCESS 3
WASTE WATER
2) REGENERATION & RE-USE
FRESH WATER
PROCESS 1
PROCESS 2
PROCESS 3
WASTE WATER
3) REGENERATION RECYCLING
FRESH WATER
PROCESS 1
PROCESS 2
PROCESS 3
WASTE WATER
WWM-A

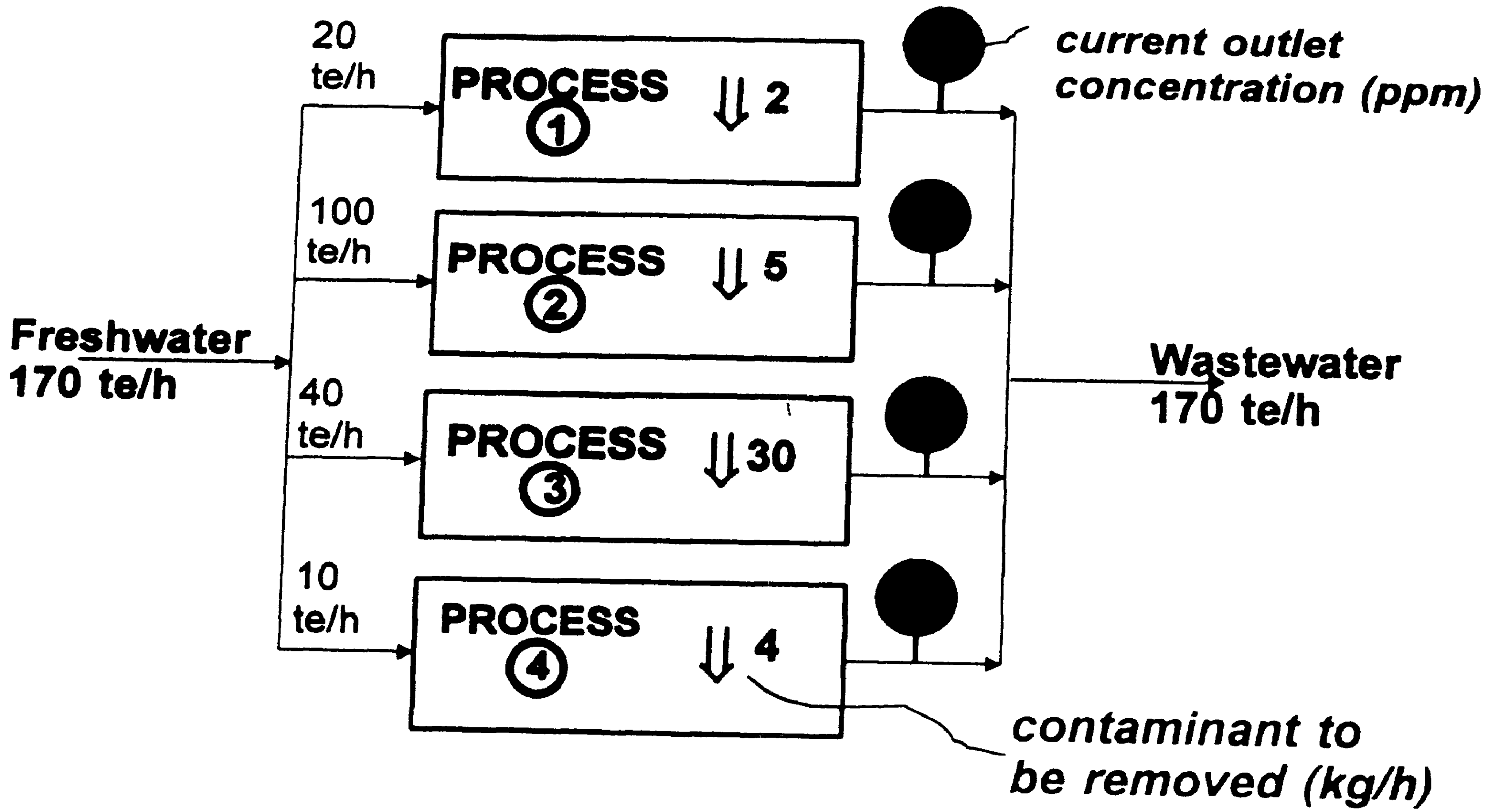
SO FAR

Wastewater Minimization

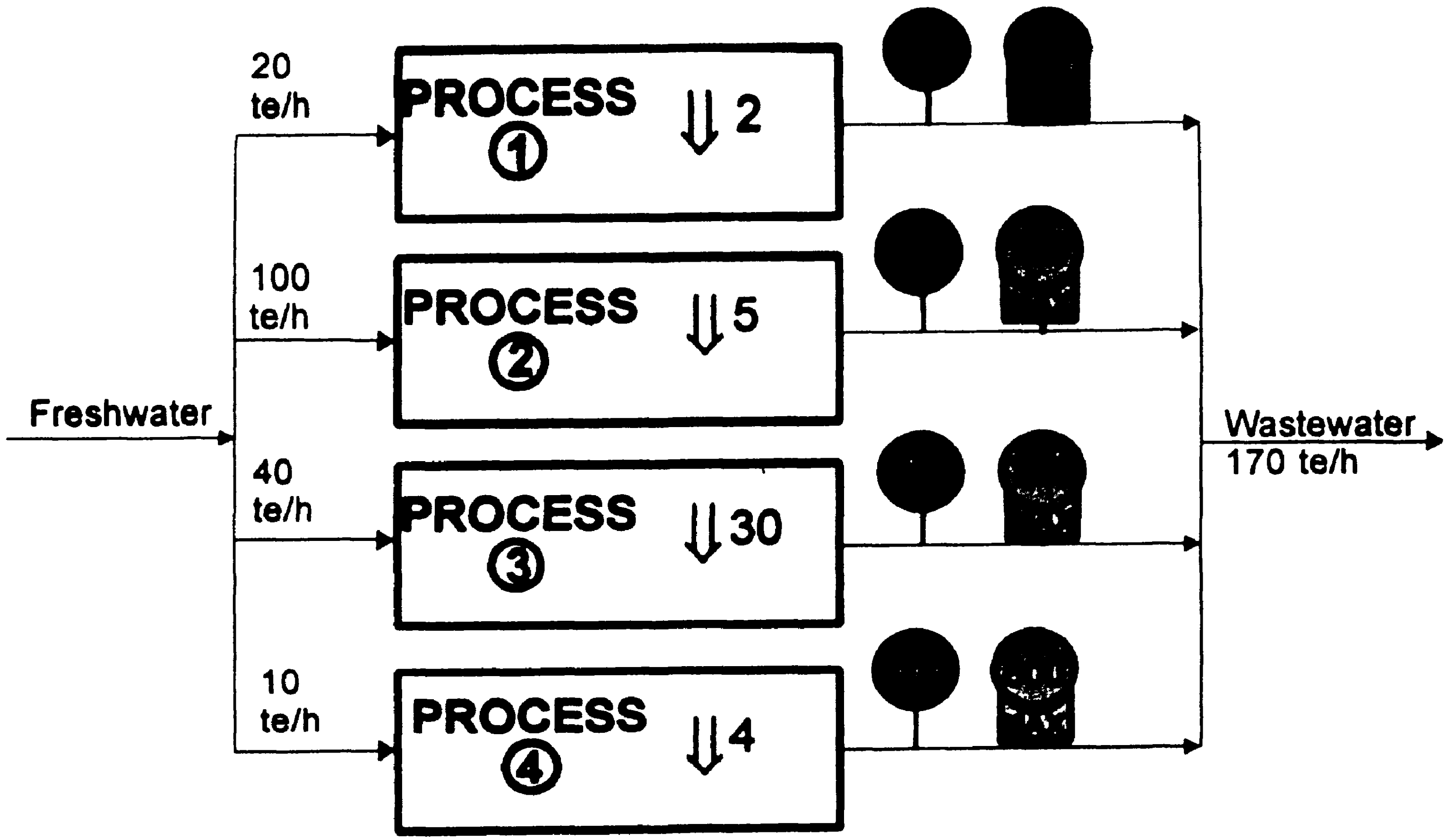
- Re-use reduces volume
- Regeneration re-use
Regeneration recycling } reduce volume and load

Traditional Approach to Wastewater Minimization

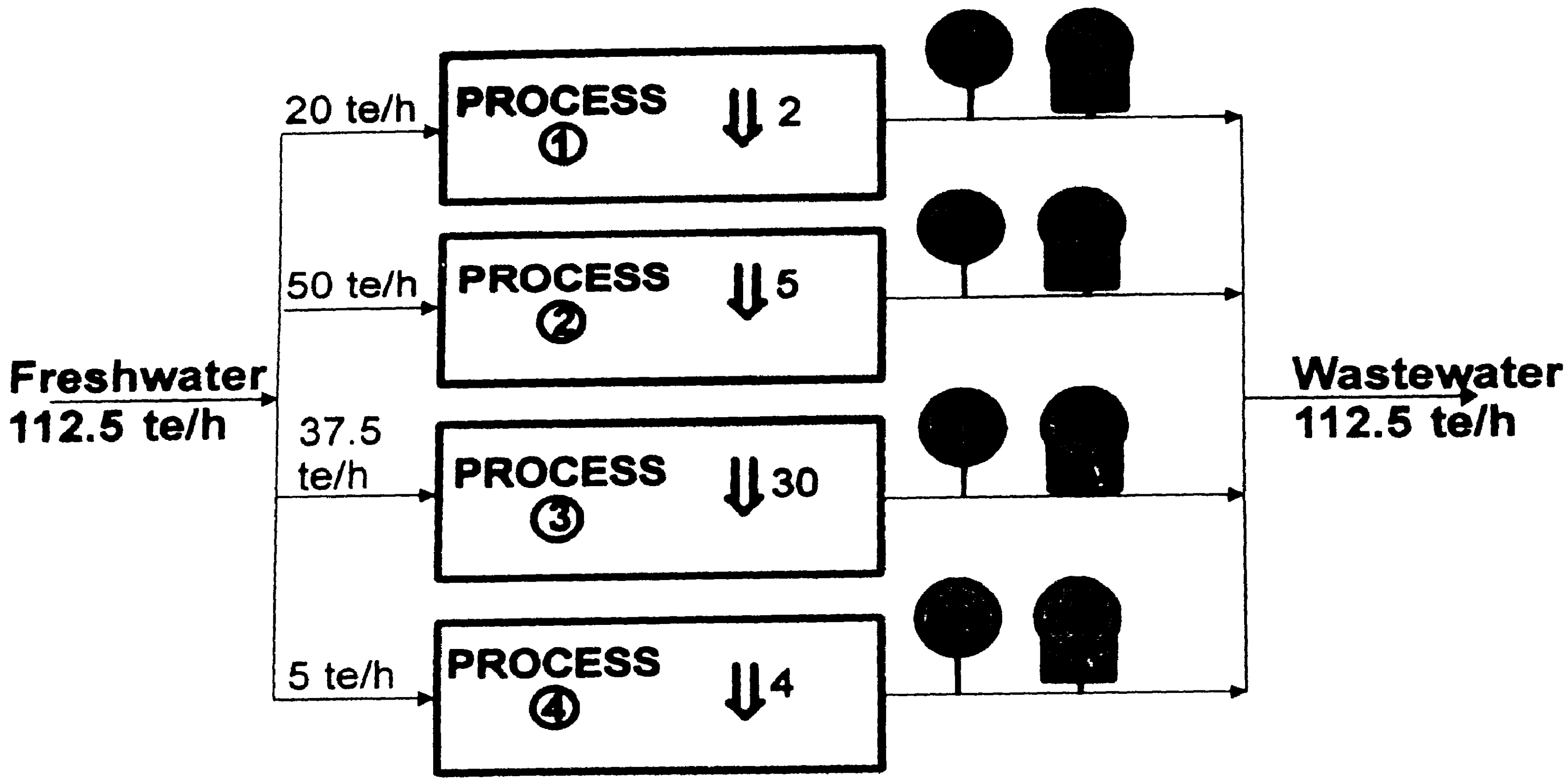
WWM-13



BASE CASE: 170 te/h



Establish Maximum Permissible Outlet Concentrations



Maximum Outlet Concentration for each Process

(Hence Minimum Total Water Use)

- OR IS IT ?

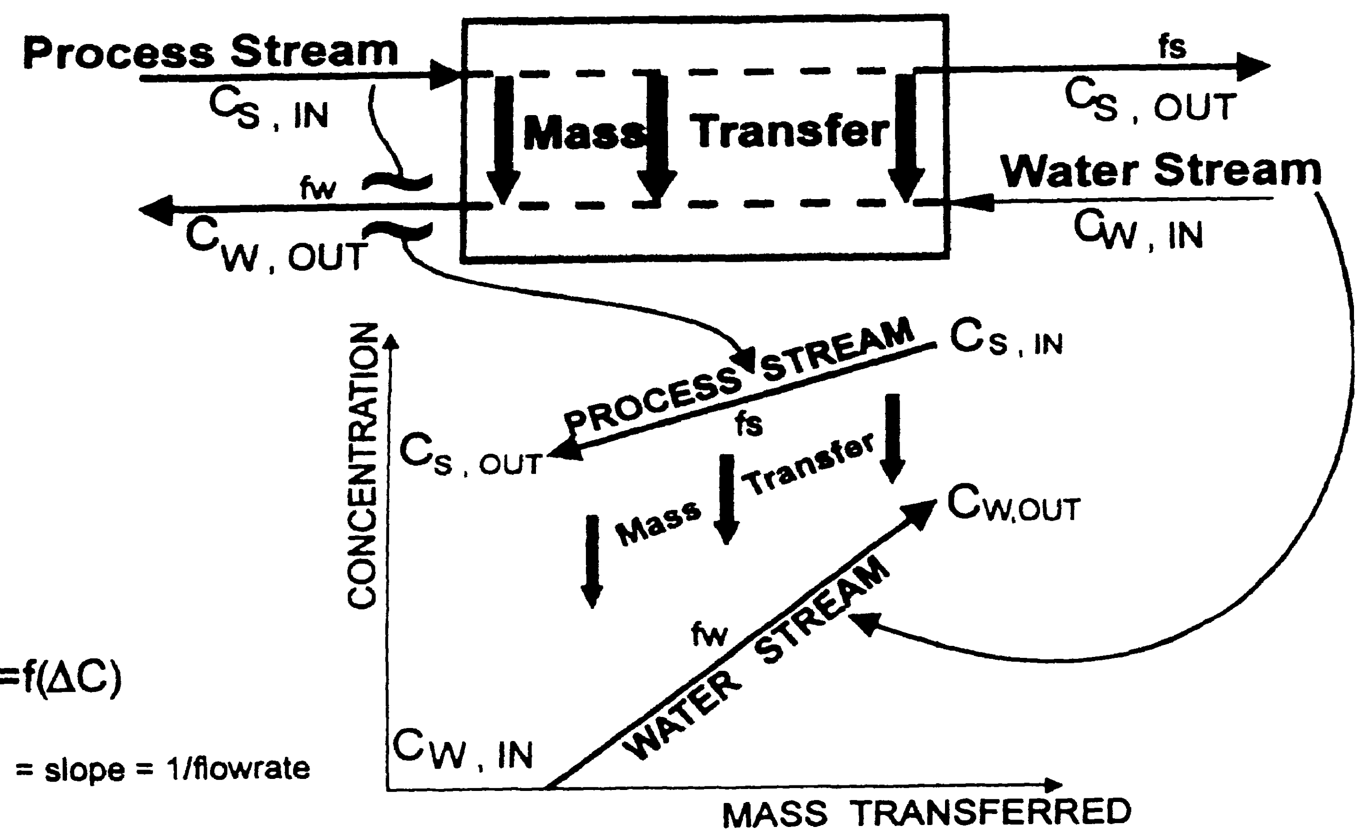
WWM-17

Have we considered all options ?

Are there any other variables we have overlooked ?

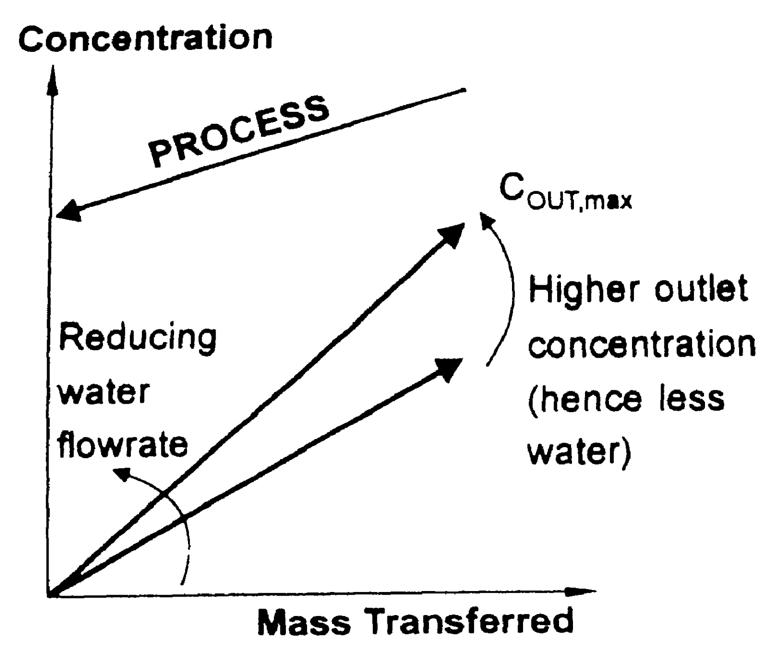
WWM-13

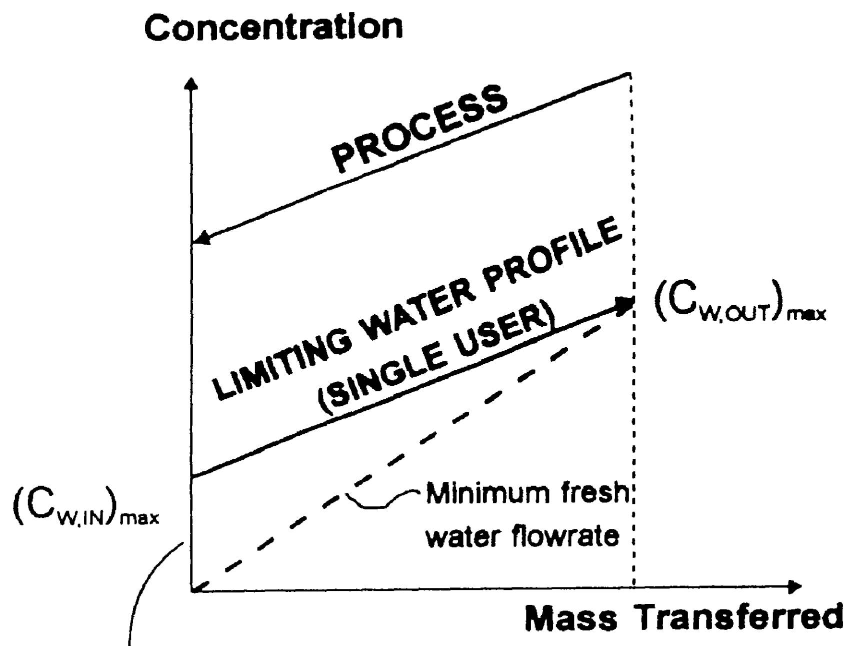
Can model any single water using operation on a plot of concentration vs mass (of contaminant)



$\Delta M = f(\Delta C)$

$\frac{\Delta C}{\Delta M}$ = slope = 1/flowrate

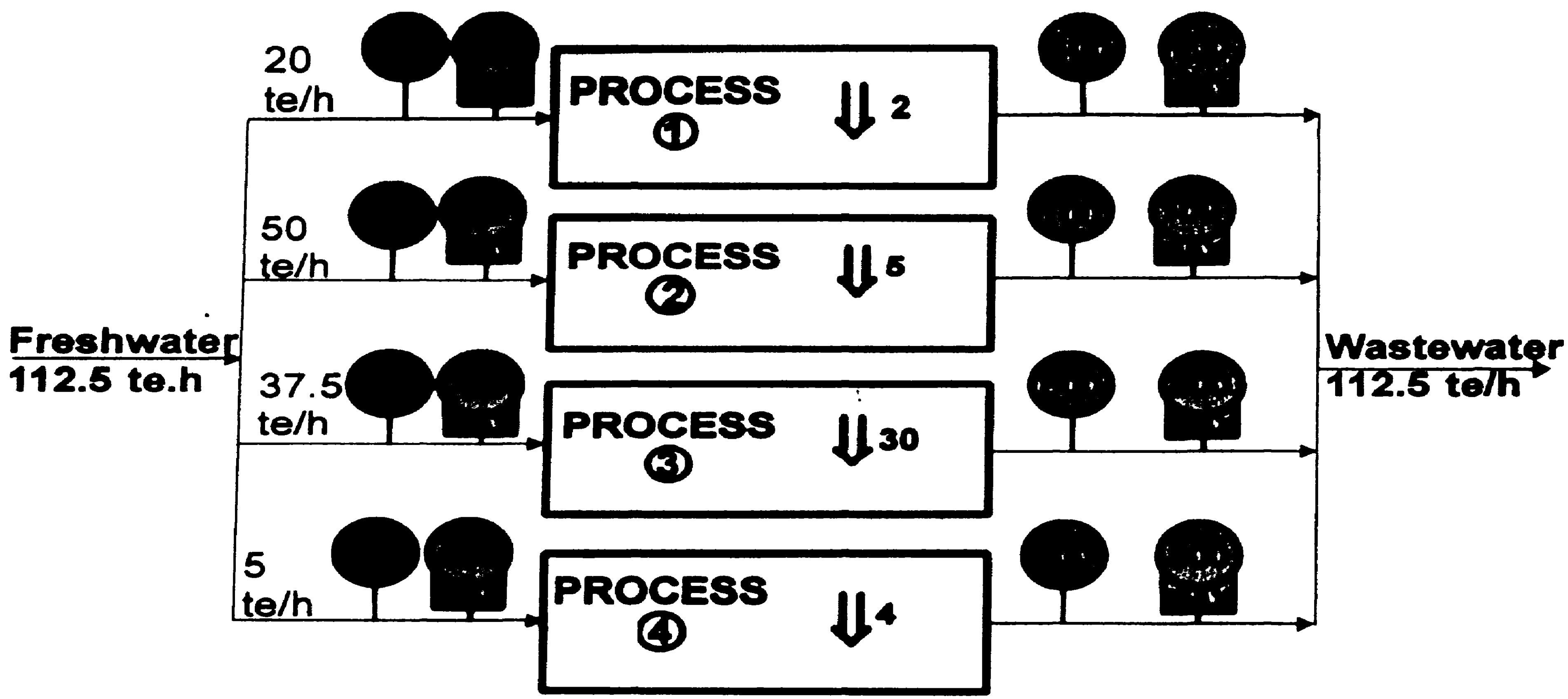




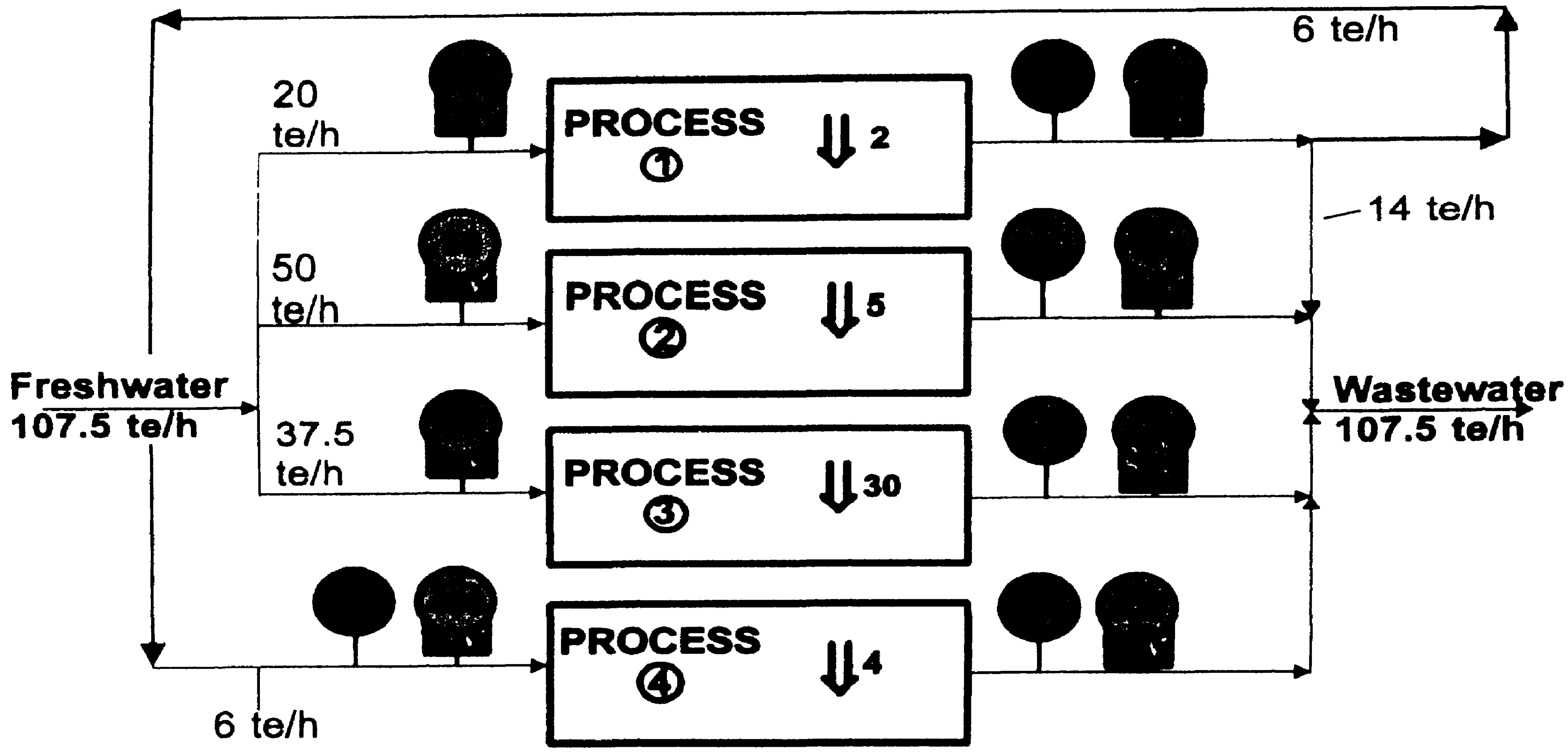
Minimum flowrate or maximum outlet concentration limits

Alternative water profile uses more water but opens up the potential to use previously polluted water

WWM-19



Establish Maximum Permissible Inlet Concentrations



RE-USE: 107.5 te/h

Base Case	170 te/h
Maximum Outlet Concentration	112.5 te/h
Re-use	107.5 te/h

But can we do better ?

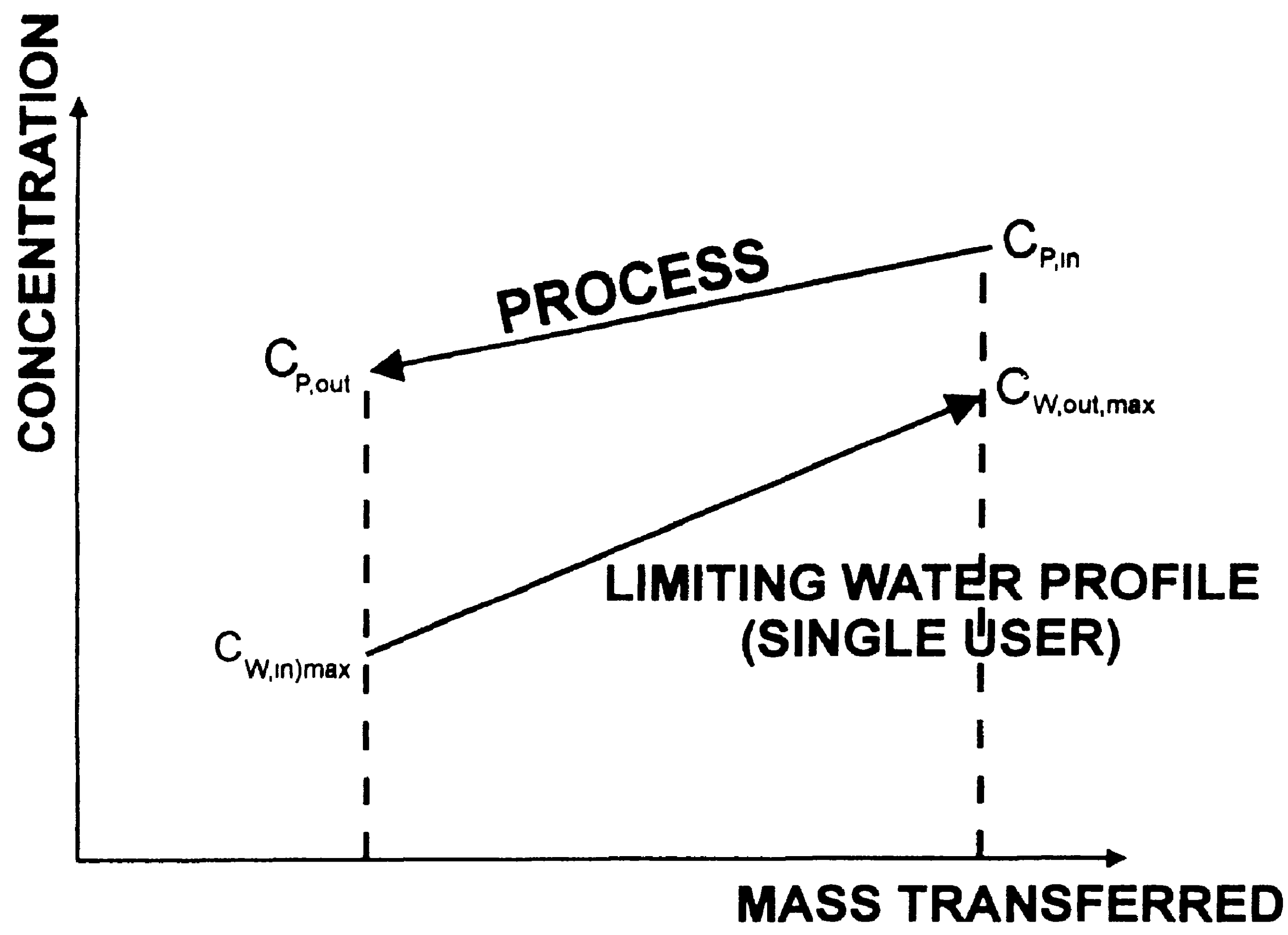
WATER PINCH

- Target the Minimum Water Flowrate
- Design to Meet the Target

WWM-23

The Data

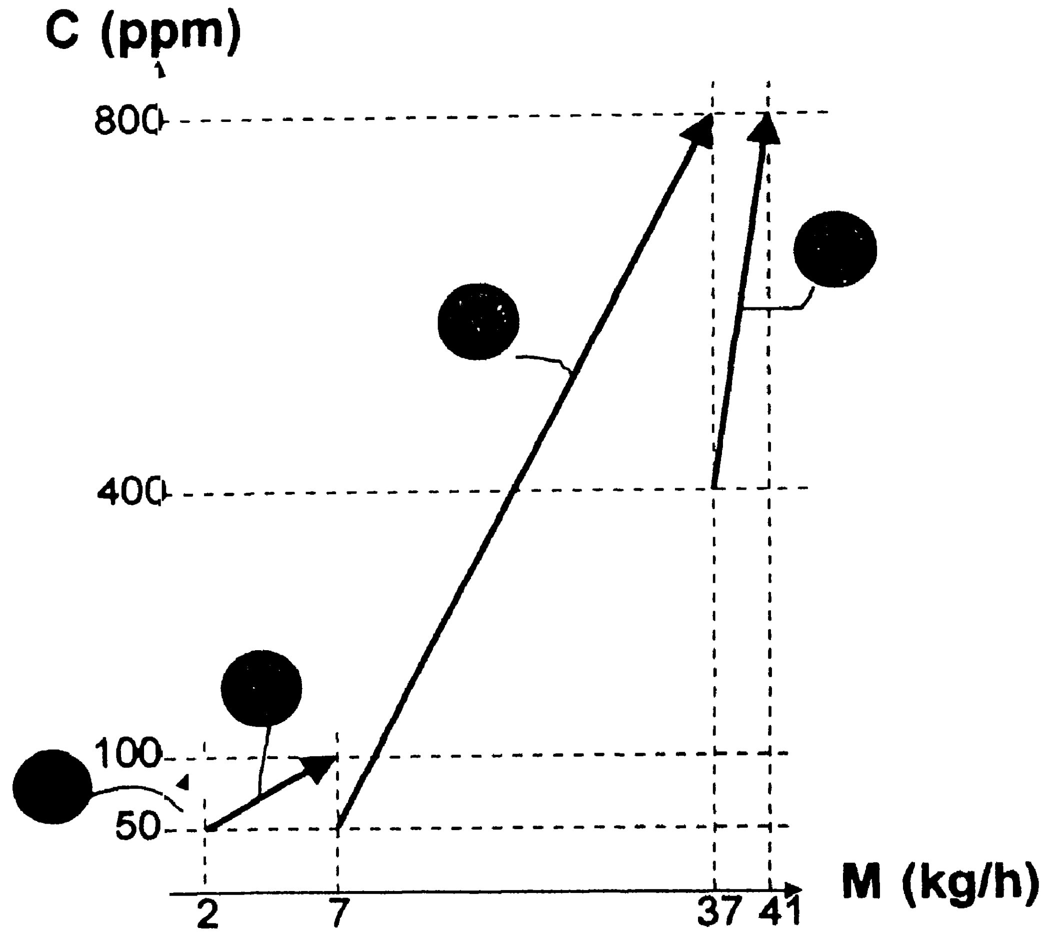
Process	Contaminant Pickup kg/h	limiting water concentrations		Flowrate tonnes/h
		C_{in}	C_{out}	
1	2.0	0	100	20
2	5.0	50	100	100
3	30.0	50	800	40
4	4.0	400	800	10
	41.0			170


CONCENTRATION
PROCESS
C P,in
C P,out
C W,out,max
C W,in)max
LIMITING WATER PROFILE
(SINGLE USER)
MASS TRANSFERRED

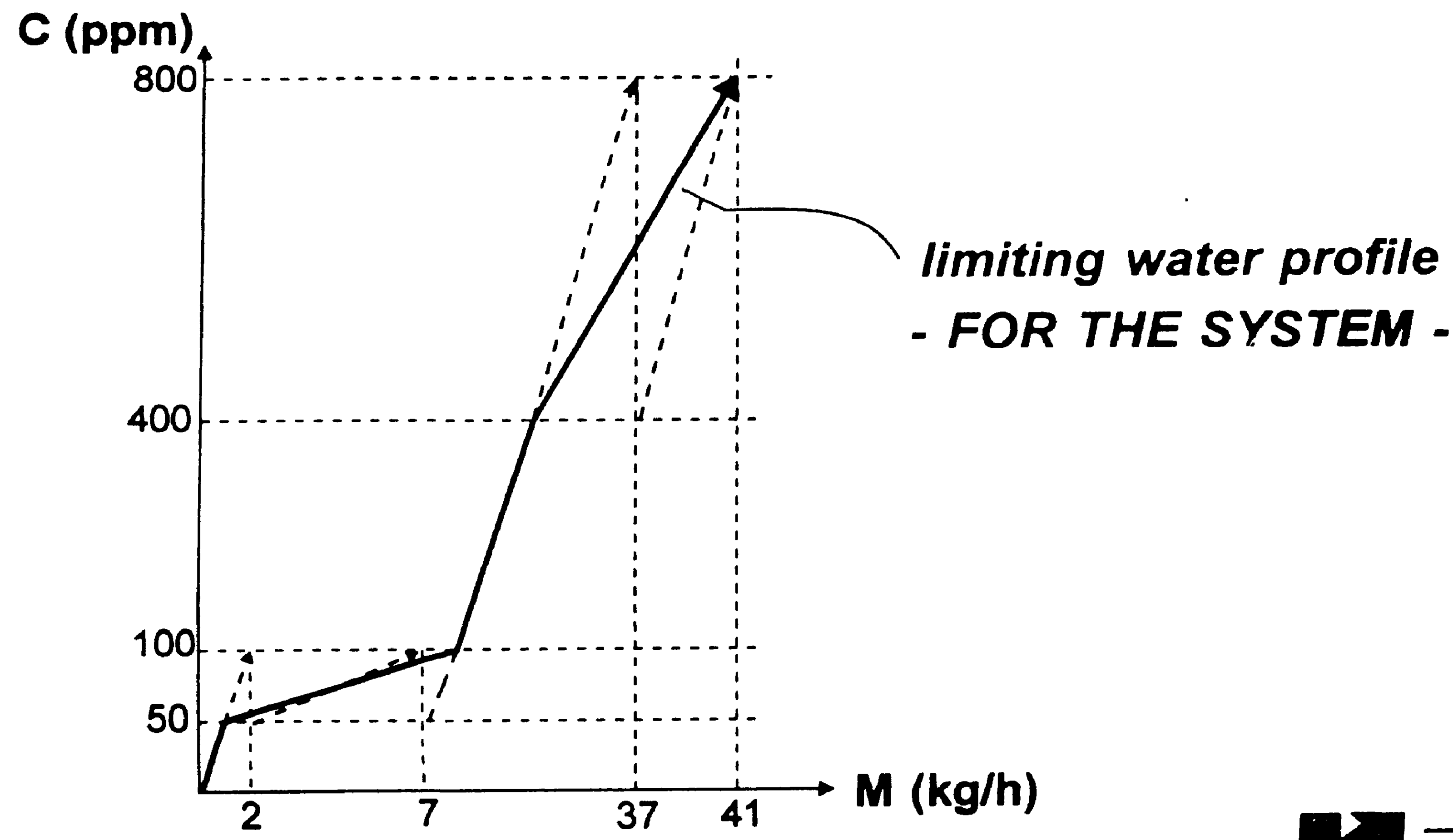
WWM-254

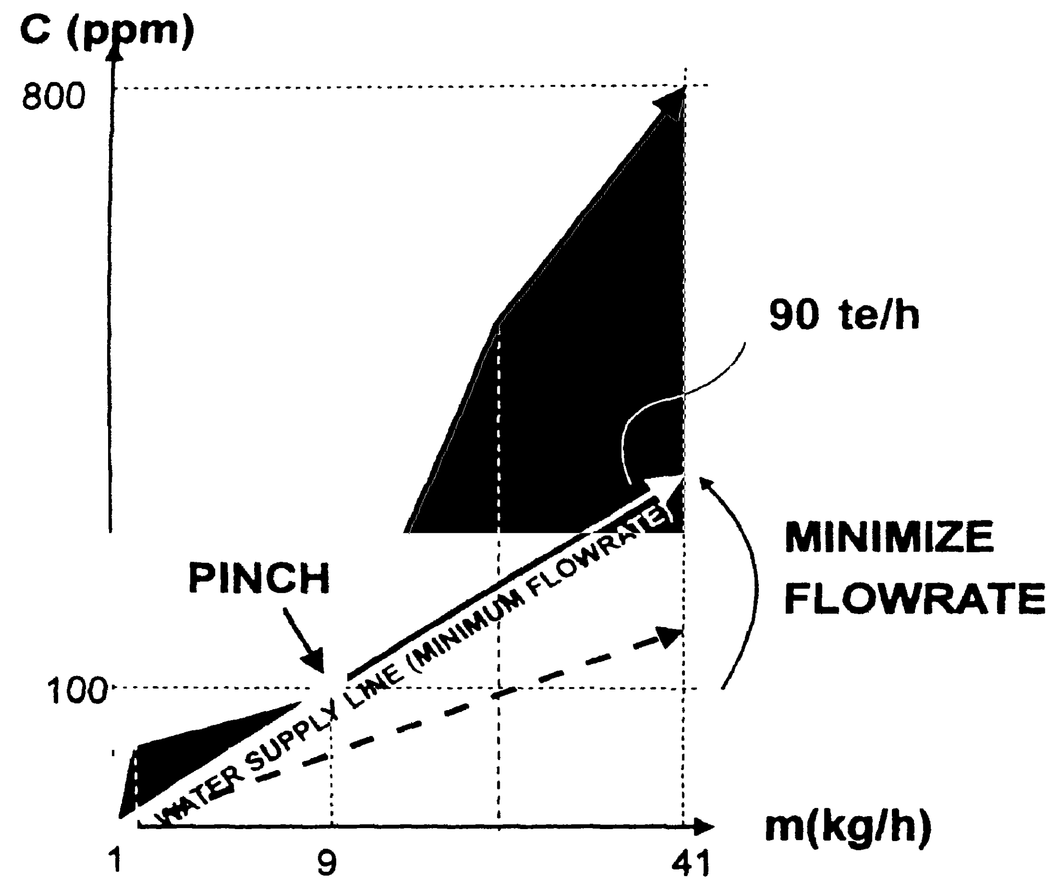
Composite Concentration Curves

PLOT LIMITING PROFILES ON COMMON AXES



ADD UP TO CREATE THE COMPOSITE CONCENTRATION CURVE

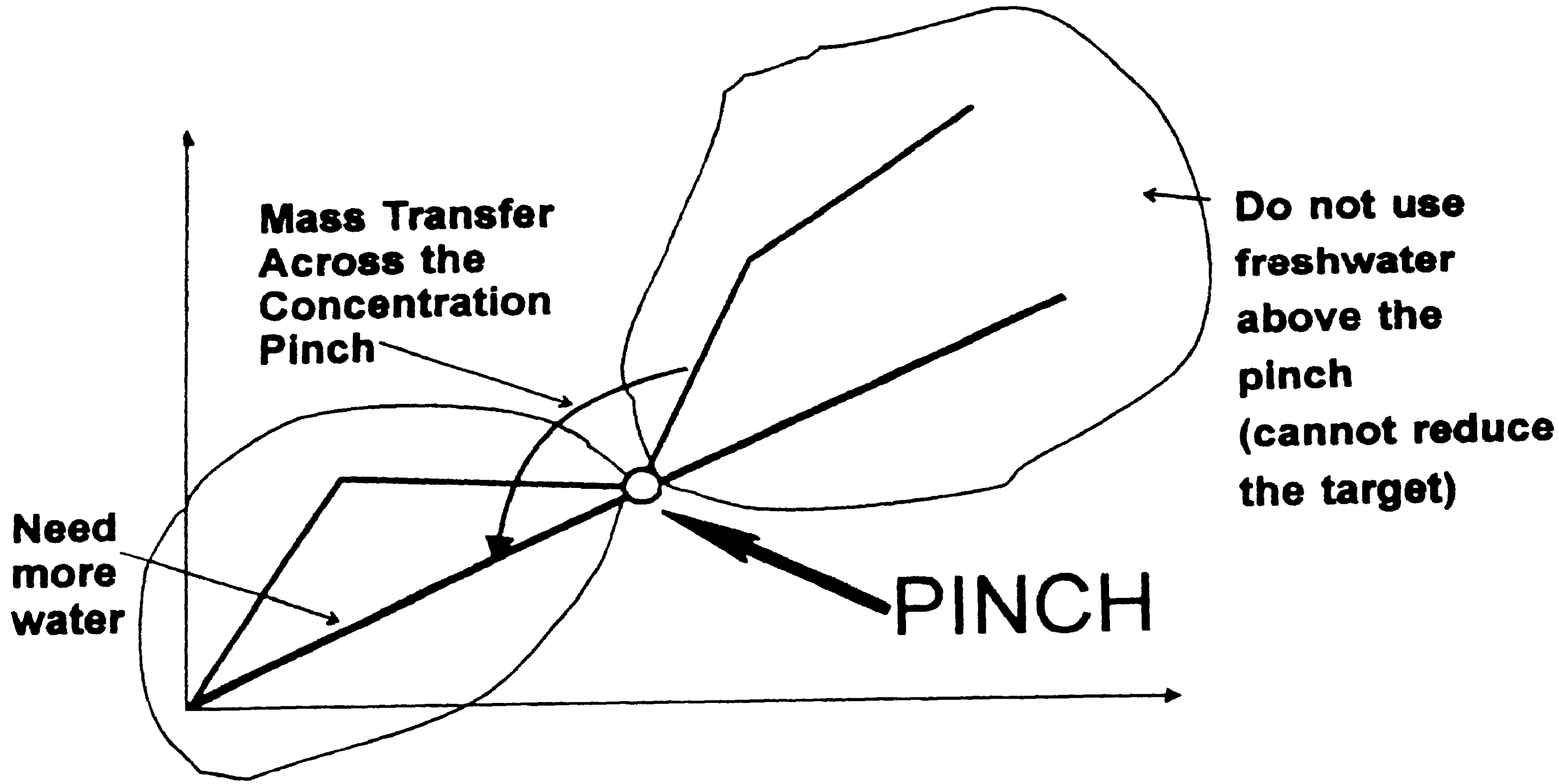




AND TARGET THE MINIMUM WATER FLOWRATE

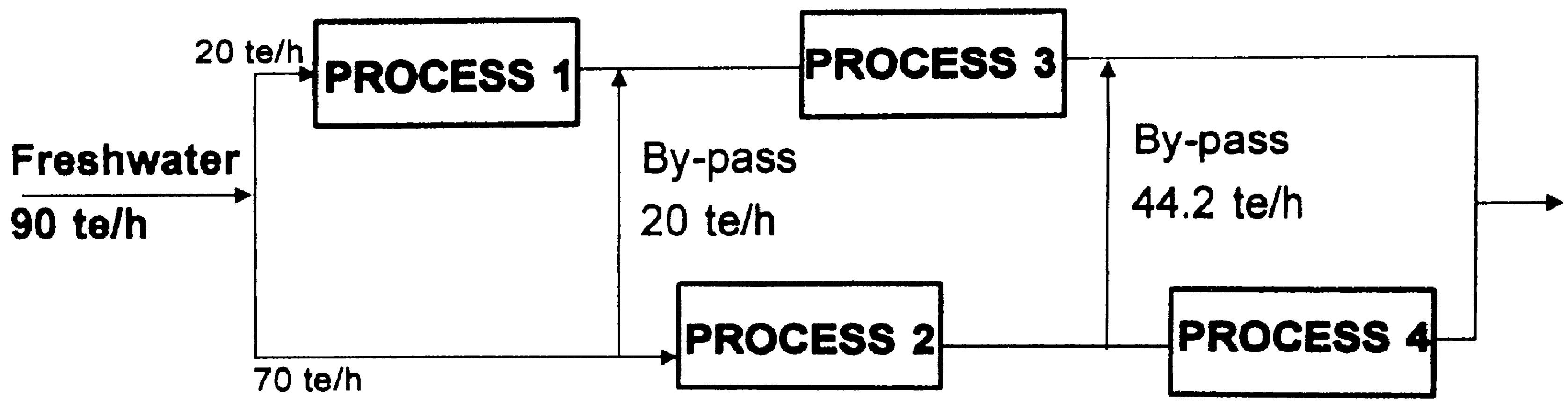
Target is only 90 te/h

WWM-28



Do Not Transfer Mass Across the Concentration Pinch !

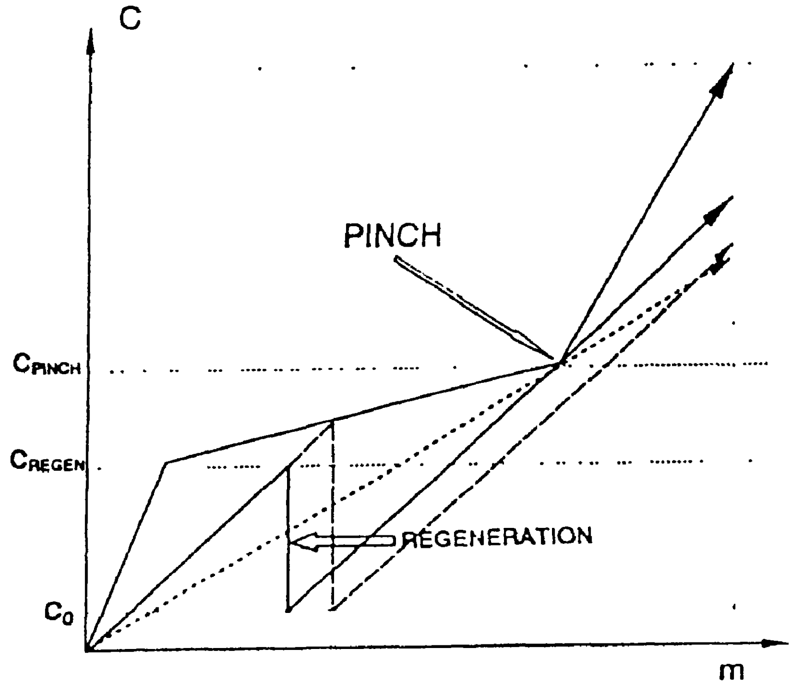
AND DESIGN TO ACHIEVE THE TARGET



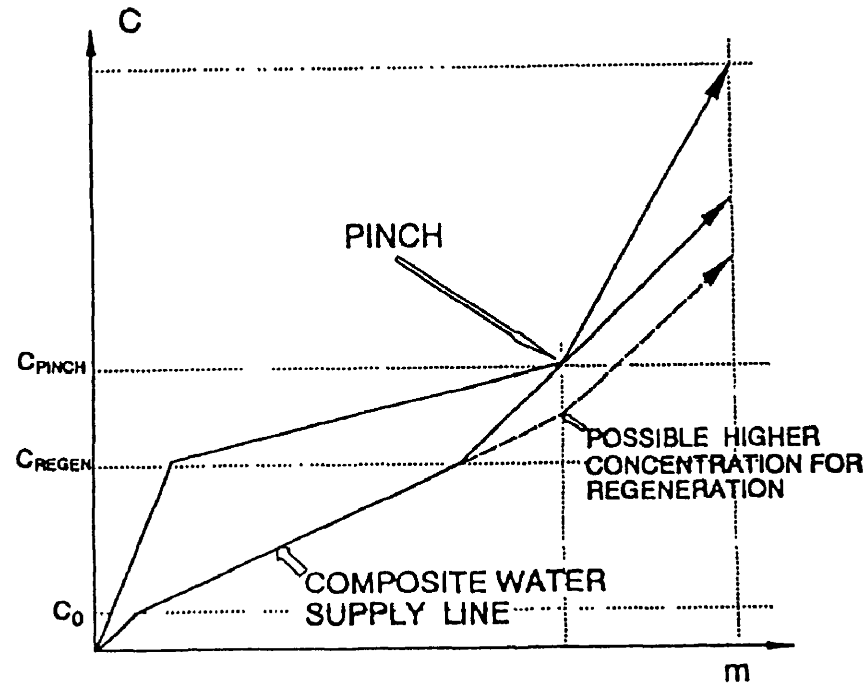
__Note__: There will typically be several designs which achieve the target

Base Case	170.0 te/h
Maximum Outlet Concentration	112.5 te/h
Re-use (by Inspection)	107.5 te/h
Re-use (on Target)	90.0 te/h

2.2 REGENERATION RE-USE

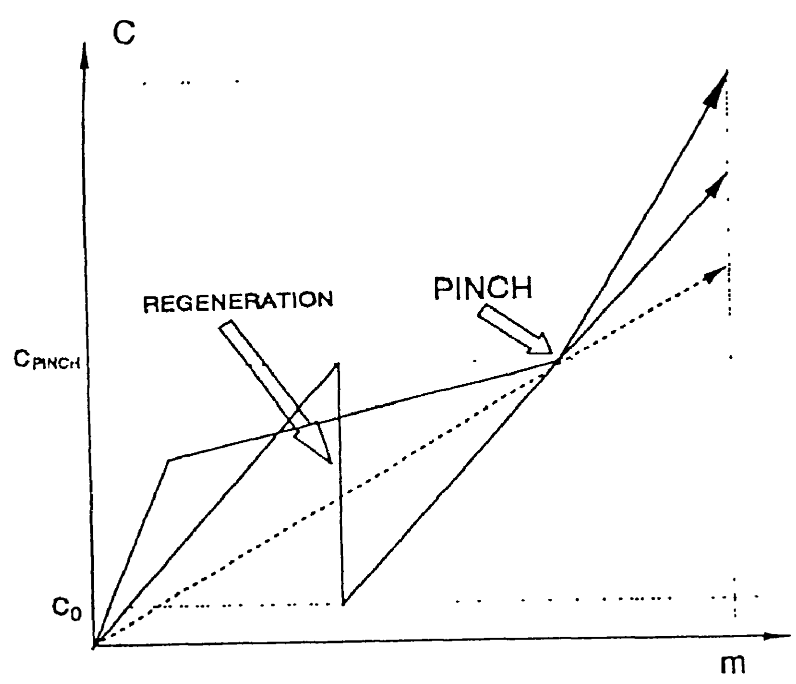


(a) Regeneration of water reduces the flowrate of freshwater and wastewater

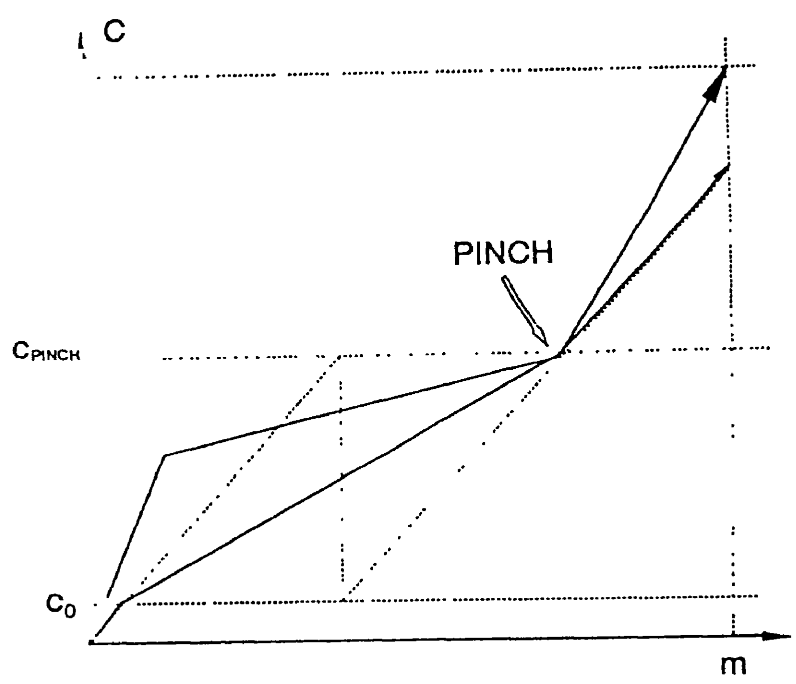


(b) Composite water supply line indicates that the water flowrate is not minimised

Regeneration of water below the pinch concentration for regeneration re-use brings a reduction in flowrate

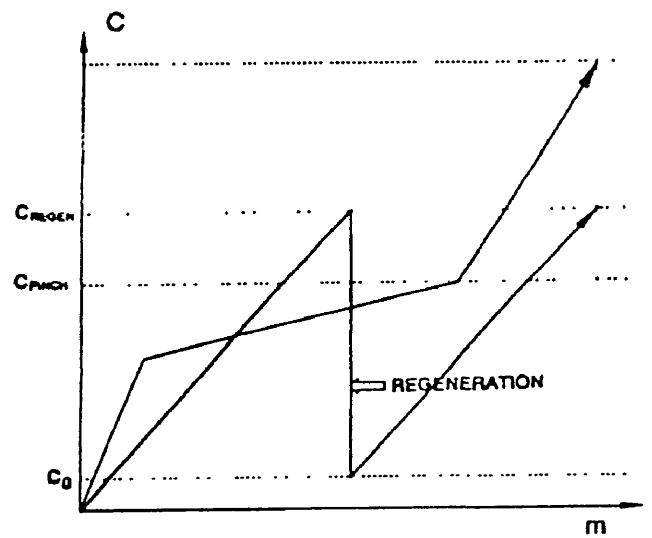


(a) Regeneration of water at pinch concentration

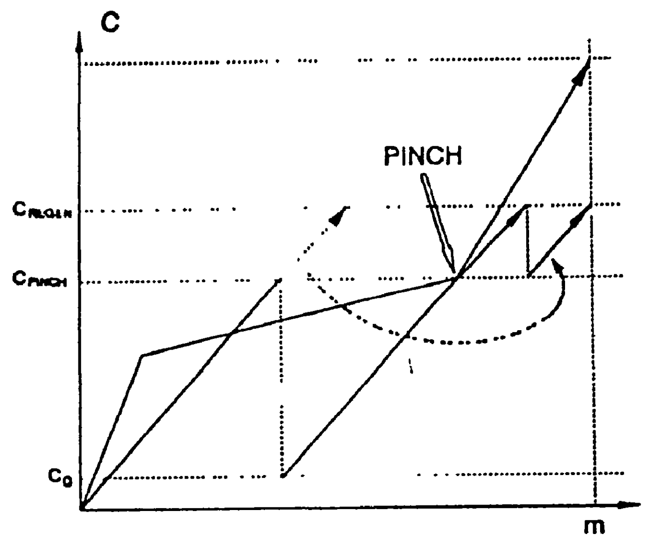


(b) A composite of the water supply line before and after regeneration indicates the water flowrate minimised

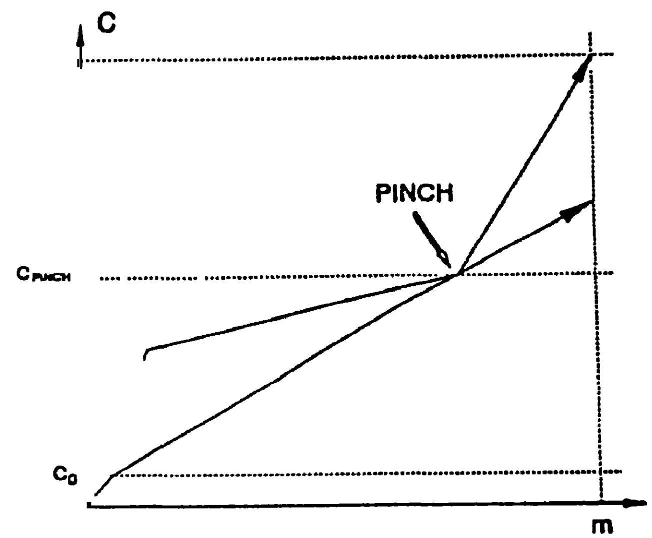
Regeneration of water at pinch concentration for regeneration re-use minimises the flowrate



(a) Regeneration of water above pinch concentration



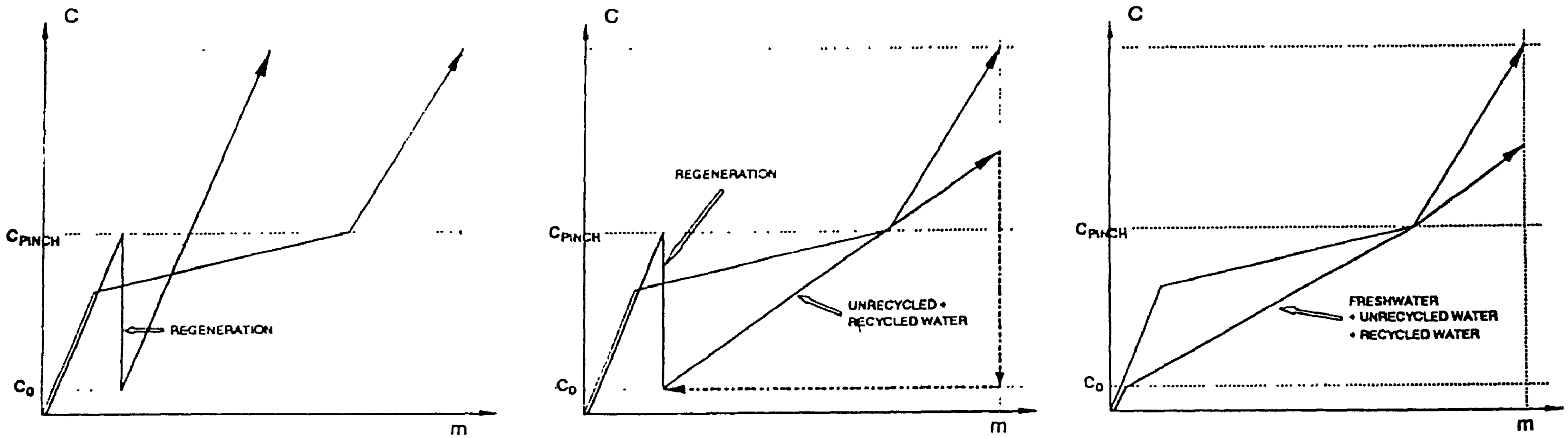
(b) Construction of a composite of water supply line



(c) A composite of the water supply line before and after regeneration indicates the water flowrate is still minimised

Regeneration of water above pinch concentration does not lower the flowrate for regeneration re-use

2.3 REGENERATION RECYCLING



(a) Minimum flowrate set by slope of limiting composite curve below C_0

(b) An increase in flowrate after regeneration requires recycling

(c) A composite of the water supply before and after regeneration

Water flowrate can be lowered to a limit set by the slope of the limiting composite curve below C_0 if recycling is allowed

EXAMPLE

No Re-use	112.5 te/h
Re-Use by Inspection	107.5 te/h
Water Pinch	
Re-Use	90.0 te/h
Regeneration Re-Use	46.2 te/h
Regeneration Recycling	20.0 te/h

WWM-354

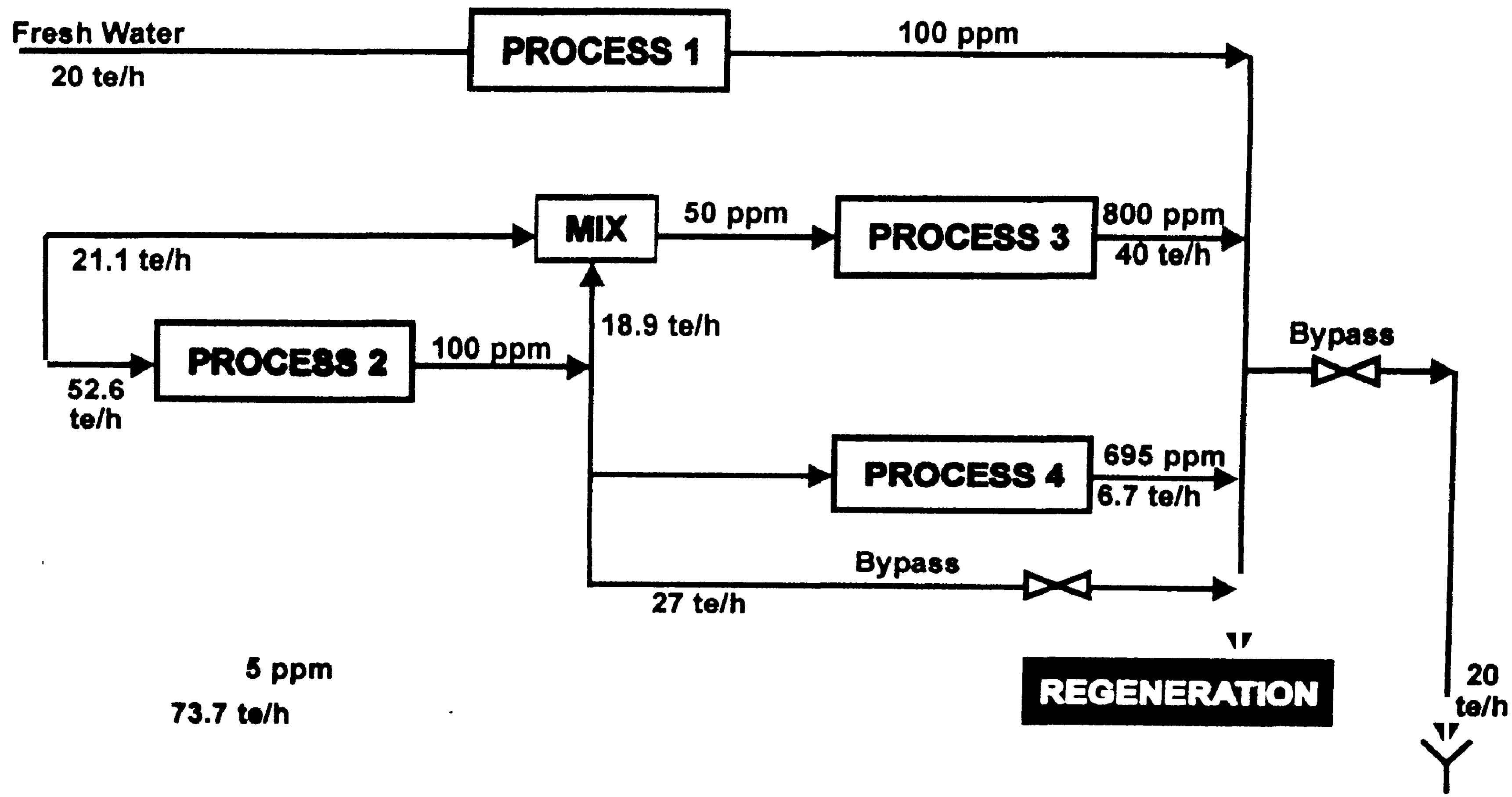
SUMMARY

WE CAN TARGET

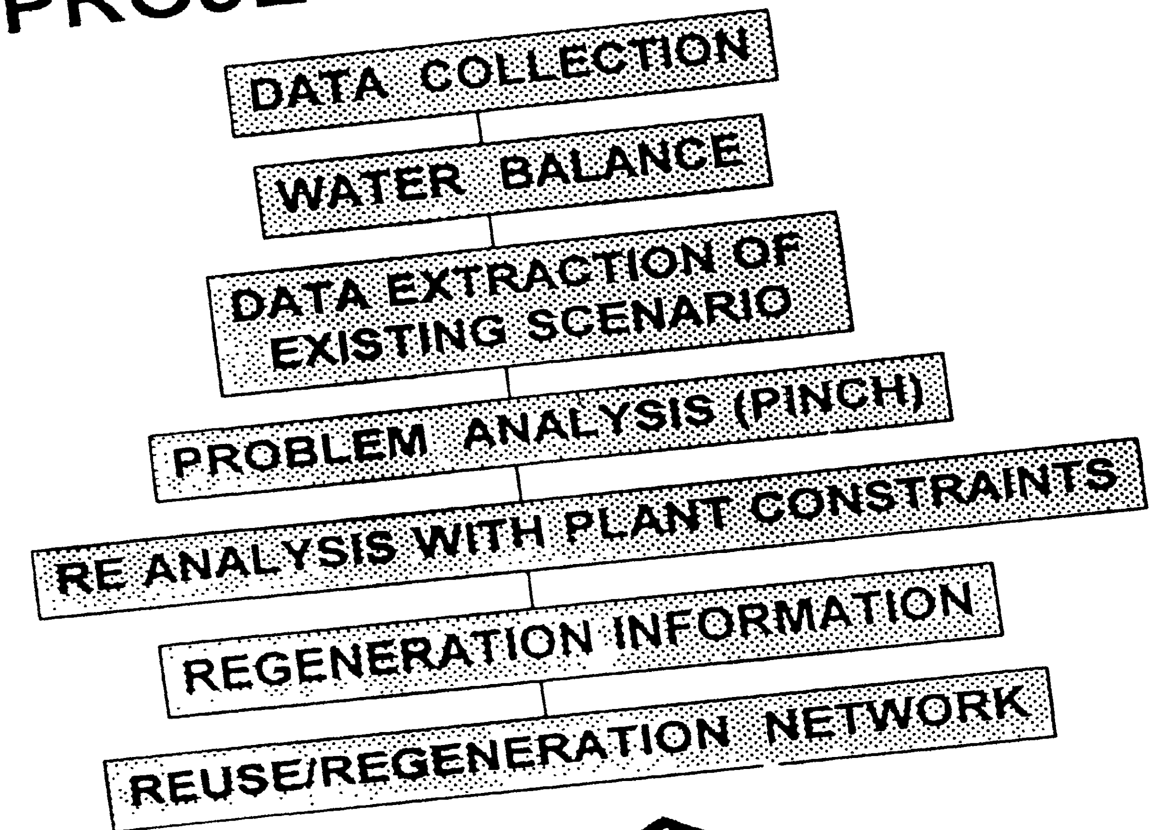
* RE-USE
* REGENERATION RE-USE
* REGENERATION RECYCLING

AND DESIGN TO ACHIEVE THE TARGETS

One of several possible solutions . . .



PROJECT APPROACH



KTI

CASE STUDIES

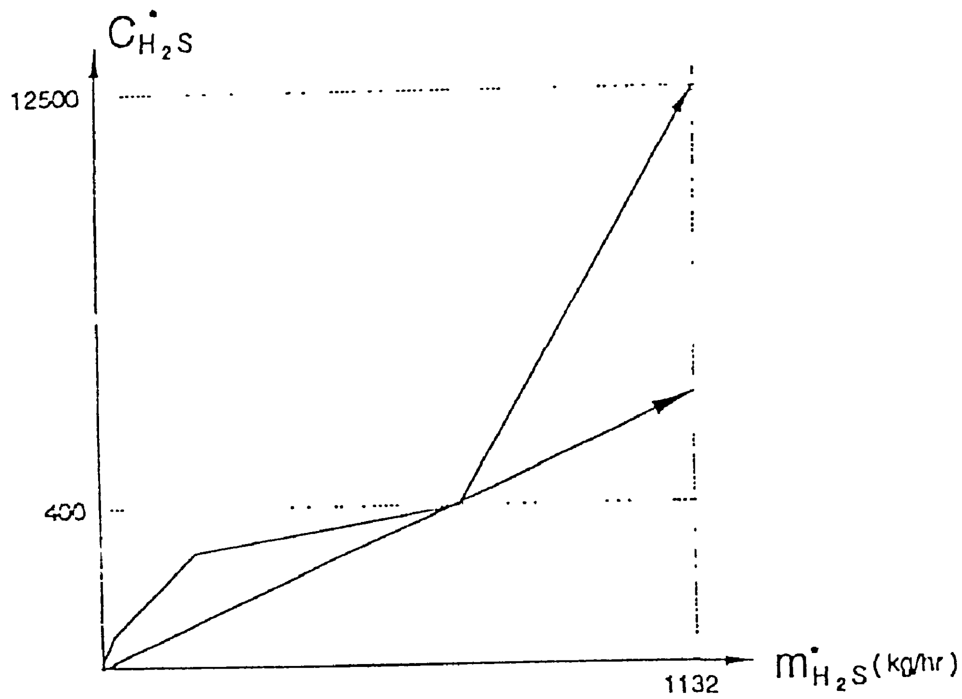
PROCESS DATA

PROCESS No	FLOWRATE te/hr	Contaminants	C_{in} ppm	C_{out} ppm
1	45	Oil	0	15
		H_2S	0	400
		Salt	0	35
2	34	Oil	20	120
		H_2S	300	12500
		Salt	45	180
3	56	Oil	120	220
		H_2S	20	45
		Salt	200	9500

ECONOMIC DATA

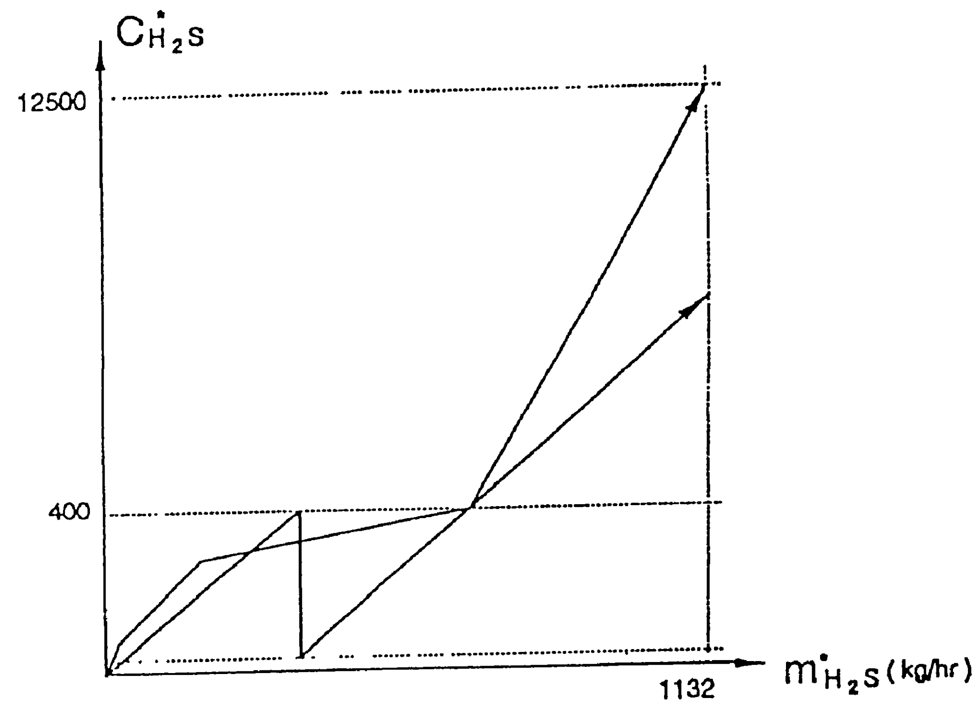
Annual Rate of Return (%)	10
Operating Hours (hr/yr)	8600
Freshwater Cost ($/te)	0.30
Cost of End-of-pipe Treatment	
Investment ($)	$34{,}200 * f^{0.7}$
Operating ($/hr)	$1.0067 * f^{0.7}$
Cost of Foul Water Stripper	
Investment ($)	$16{,}800 * f^{0.7}$
Operating ($/hr)	$1.0 * f^{0.7}$

* NO RECYCLING
* REGENERATION POSSIBLE WITH A FOUL WATER STRIPPER WITH REMOVAL RATIO $R = (0, 0.999, 0)$



Target Without Regeneration

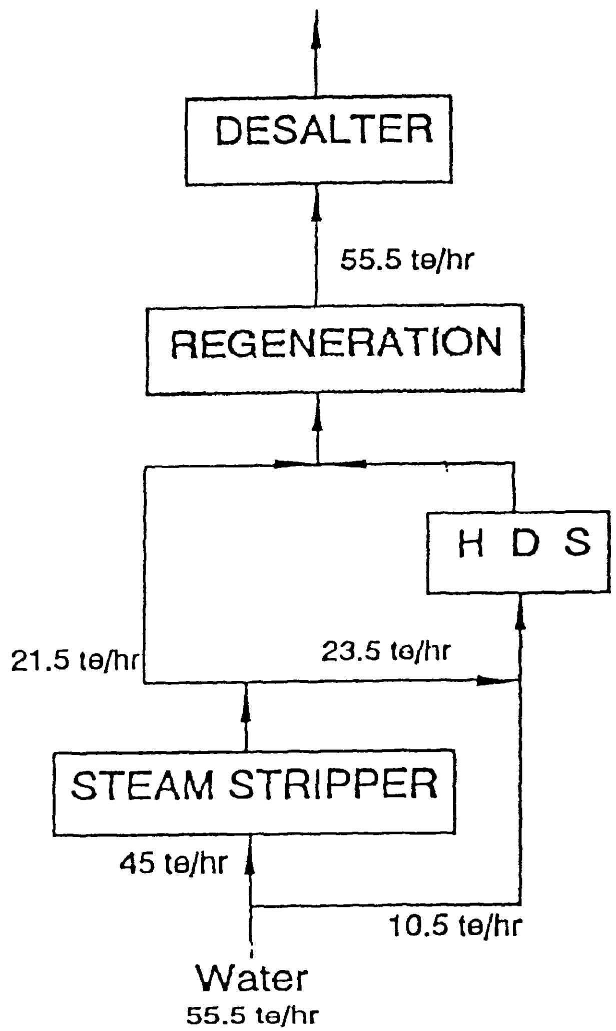
(f = 106.7 te/hr)



Target for Regeneration Re-use

(f = 55.5 te/hr)

DESIGN TO ACHIEVE THE TARGETS (Method 2)



COMPARISON OF THE RESULTS

		FLOWRATE te/hr	Annual Cost MM$
WITHOUT RE-USE		133	1.599
RE-USE WITHOUT REGENERATION		107	1.292
REDUCTION	△	26	0.307
	%	20	19
REGENERATION RE-USE		55.5	1.186
REDUCTION	△	77.5	0.413
	%	58	26

CASE STUDY : MONSANTO

BACKGROUND

EXISTING SITUATION :

- 8 SPECIALITY CHEMICAL PLANTS
- EXISTING EFFLUENT FLOW 90,000 cu. m/month WITH LOAD OF 200 t/month TOD
- EFFLUENT COLLECTED TOGETHER, ADJUSTED FOR pH AND DISCHARGED
- RIVERS AUTHORITY LOOKING FOR 90% REDUCTION IN TOD

INITIAL PROPOSAL :

- NEW CENTRAL EFFLUENT TREATMENT PLANT
- CAPITAL COST ESTIMATE US $ 15 MILLION

OBJECTIVES

- TO IDENTIFY PROJECTS TO REDUCE FRESH WATER USE WHICH WOULD INTURN REDUCE EFFLUENT VOLUMES AND HENCE THE CAPITAL COST OF ANY EFFLUENT TREATMENT FACILITY

- TO REDUCE EFFLUENT AT SOURCE BY A COMBINATION OF WASTE MINIMISATION ACTIVITIES AND DISTRIBUTED EFFLUENT TREATMENT PLANT

STRATEGIES

A) FOR REDUCING FRESH WATER CONSUMPTION

1. RE-USE WITHIN INDIVIDUAL PROCESS

2. RE-USE BETWEEN DIFFERENT PROCESSES

SUBSTITUTION OF FRESH WATER FOR

- FIRE WATER MAKE-UP
- CATION BED WASH WATER
- COOLING TOWER MAKE-UP
- LIME SLURRY MAKE-UP

STRATEGIES

B) FOR REDUCING COD LOAD

1. WASTE MINIMISATION AT SOURCE

* 'EASY WIN' PROJECTS WHICH ARE OBVIOUS
* TARGET THE STREAMS WHICH MAKE A MAJOR CONTRIBUTION TO THE COD LOAD AND LEAD TO RAW MATERIAL SAVINGS

2. DISTRIBUTED EFFLUENT TREATMENT

* CONCENTRATED EFFLUENTS AND DILUTE EFFLUENTS ARE TO BE TREATED SEPARATELY

RESULTS

CAPITAL COST : US $ 3.5 MILLION (75% REDUCTION)

OTHER BENEFITS :

* 30% WATER REDUCTION (US $ 0.3 MILLION/YR SAVING)
* 76% COD REDUCTION (US $ 0.7 MILLION/YR SAVING)
* REMAINING COD REMOVED BY EFFLUENT TREATMENT

CASE STUDY : DRALON PLANT

OBJECTIVES

* TO DETERMINE THE POTENTIAL FOR WASTE WATER REDUCTION
* TO IDENTIFY PROJECTS BY WHICH THIS REDUCTION CAN BE ACHIEVED

METHODOLOGY

OBTAIN MINIMUM WATER FLOW RATE BY

- KEY COMPONENT ANALYSIS
- FLOWSHEET INSPECTION
- NON-LINEAR PROGRAMMING

RECOMMENDATIONS

PROJECTS	FRESH WATER SAVING (t/h)
Re-use of vent scrubber effluent in polymerisation	1.7
Re-piping of Dralon-T filtrate to MWB2	2.0
Operating Dralon X+T at Dralon X contamination levels	2.7
Upstream dewatering in ploymerisation	5.0
Aftertreatment with improved mass transfer	5.2
Integration of polymerisation and aftertreatment	29.3

CONCLUSIONS

- WATER PINCH PROVIDES CONCEPTUAL INSIGHTS FOR WASTE WATER MINIMISATION
- COMPLEMENTS TRADITIONAL APPROACH
- IDENTIFIES CRITICAL UNITS - THOSE AROUND THE PINCH
- PROVEN TRACK RECORD WITH 30 - 60% SAVINGS
- CAN BE APPLIED TO ALL INDUSTRY SECTORS INCLUDING TEXTILE INDUSTRY

PINCH ANALYSIS FOR WASTE WATER MINIMISATION IN TEXTILE INDUSTRY

PROCESS SYSTEMS SERVICES DIVISION
KINETICS TECHNOLOGY INDIA LIMITED
NEW DELHI

TRAINING PROGRAMME ON
ENERGY EFFICIENCY AND ENVIRONMENT IMPROVEMENT IN
TEXTILE INDUSTRY
4 - 6 MARCH 1998

Integrated Electrical Energy Conservation Approach In a Spinning Mill Crushing

D K Bhattacharya
NITRA

INTEGRATED ELECTRICAL ENERGY CONSERVATION APPROACH IN A SPINNING MILL

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The Textile Industry which is one of the largest and oldest industries in India has been passing through crisis on account of uneconomic working due to steep escalation in power cost, shortage of power supply and out dated production techniques and equipments. The Government as well as private owned textile groups are aware of the need for modernisation and steps in this direction is underway.

Power and utility play a vital role in running the wheels of textile and other related sectors. In the past, power and utility cost of textile sector was only 3%-4% of total cost structure, but dut to recent price hike of coal and fuel oil, this cost has gone upto 15%-20%. The electrical tariffs are expected to go up further and are likely to double in next few years.

Today there is a great need of constant review and renovation in the electrical equipments to achieve lower consumption of electricity. Also every technician either from engineering or from production/maintenance etc., should be aware regarding energy conservation. Maintenance of mechanical and electrical equipments in spinning section is of equal importance. But in practice while the former is given its due importance by the department personnel themselves, the latter is left to the mercy of engineering department. There is a lack of coordination between the two and as a result many a times there are occasions when both sides blame each other. The energy conservation activity can not be successful with the chief engineer alone, production and maintenance people can also give lot of help to reducing power consumption i.e. proper machinery maintenance and optimisation of productive parameters and introduction of new energy saving devices i.e., use of synthetic spindle tape, use of lower wharve dia spindle, use of better quality of spindle oil etc., and also they can help to reduce wasteful power i.e., idle running of motors, reducing excess lighting in the department, etc. Because the engineering people are not very much aware with the textile processes, only mechanical people to play a vital role for guiding him about the machines functions.

ENERGY CONSERVATION SCOPE IN A TEXTILE MILL

In a recent Energy survey conducted by NPC, it was revealed that there is a good scope of energy saving in textile mills to the extent of about 5%-10% in electrical energy; and 15%-30% in thermal energy. The scope can be categorised as follows :

Sl. No.	Type of Implementation	Scope of Saving(%)
1.	Improvement of house keeping	3% to 5%
2.	Short Term Measures - Replacement of old/inefficient small equipments/parts - Improving work practices - Overhauling/lubrication etc.	
3.	Mid Term Measures - Renovation/Part renovation - Performance improvement	5% to 10%
4.	Long Term Measures - Modernisation - Major process change - Complete replacement	More than 10%

The problem with the textile mills is that the energy conservation activity has not been given the one priority it deserves. There may be various reasons for this apathy like old machineries, financial constraints, lower profits, change of priority etc.

But in order to survive in the stiff competitive market one has to give priority to reduction in the cost of production and the very fact that the cost of energy is escalating at a much faster rate than other cost components, the mill have started endeavoring hard to cost reduction through energy conservation.

In order to achieve best results from energy conservation activity the mill has to adopt the following procedures religiously :

1. IFC Survey between similar mills.

2. Detailed Energy Audit by Experts.

3. Formation of Energy Conservation Cell.

4. Energy Consumption Analysis.

5. Implementation Strategy

   - short term

   - medium term

   - long term

6. Financial provision

7. Implementation Monitoring

8. Training-cum-Campaigning

9. Incentive scheme

10. Accountability

Various areas of energy conservation are being discussed in the form of studies in this paper in the subsequent chapters.

1. OVERMOTORING

As such normally maximum efficiency of motors occurs at 75% of load current of all the motors should be measured and it should be tabulated alongwith its rated current. It should be done for the entire mill. Wherever it is found that the loading of the motor is less than 65%, then the motor should be replaced as the efficiency of the motor will be low at lower loading. NITRA has done lot of studies on it. One such study was done in a mill in doubling section, the current drawn by the motors was only 10.0 to 10.5 Amps. against full load of 17.5 Amps., which means the loading is 58%, it is obvious that the efficiency of the motor will be very low. One solution is to replace the motor by lower H.P. which involved capital investment and in the present condition of textile mills it is rather difficult. An alternate solution for the above was thought of to increase the efficiency of the present motor itself. We thought of changing the motor connection from delta to star. We have measured the current in delta as well as in star without affecting the production. The datas are given below in Table Nos.1 & 2.

TABLE-1 : ENERGY CONSERVATION OF DOUBLING (Delta to Star Connection)

S.No.	Connection	Load Current (Amps)	HP	Rated Current (Amps)	Power Saving (KWH)	Current (Amps)	PF	No.of M/cs
1.	Delta	15.0	25	32.0	1.2	8.5	0.4-0.8	3
	Star	6.5						
				T.F.O.				
2.	Delta	32.0	50.0	64.0	2.5	9.0	0.6-0.9	7
	Star	23.0						
3.	Delta	32.0	60.0	78.0	2.6	7.0		
	Star	25.0						
4.	Delta	40.0	60.0	78.0	2.0	10.0		
	Star	30.0						
5.	Delta	18.0	20.0	28.0	0.75	8.0	0.5-0.9	9
	Star	23.0						

TABLE-2 : ENERGY CONSERVATION OF SPEED FRAMES

M/c Make	Connection	H.P.	Load Amps.	Starting Load (Amps.)	P.F.	Motor Temp. °C	KWH
L.R.	Delta	12.5	10	80	0.52	50.1	3.6
	Star	12.5	5	30	0.94	47.0	3.2
M.M.C.	Delta	10.0	7.5	50	0.55	51.0	2.86
	Star	10.0	4.5	30	0.85	45.0	2.60

Note : This applies only to condition where motor loading is less than 50%.

Other Advantages of Reduction of Overmotoring

(i) Improvement of overall system efficiency

(ii) Reduction of line losses

(iii) Reduction of heating of cables, panels, etc.

(iv) Saving of Capacitors

(v) Reduction of MD

There are many other areas where lot of overmotoring exists like Ring-frames, Humidification fans & Pumps etc.

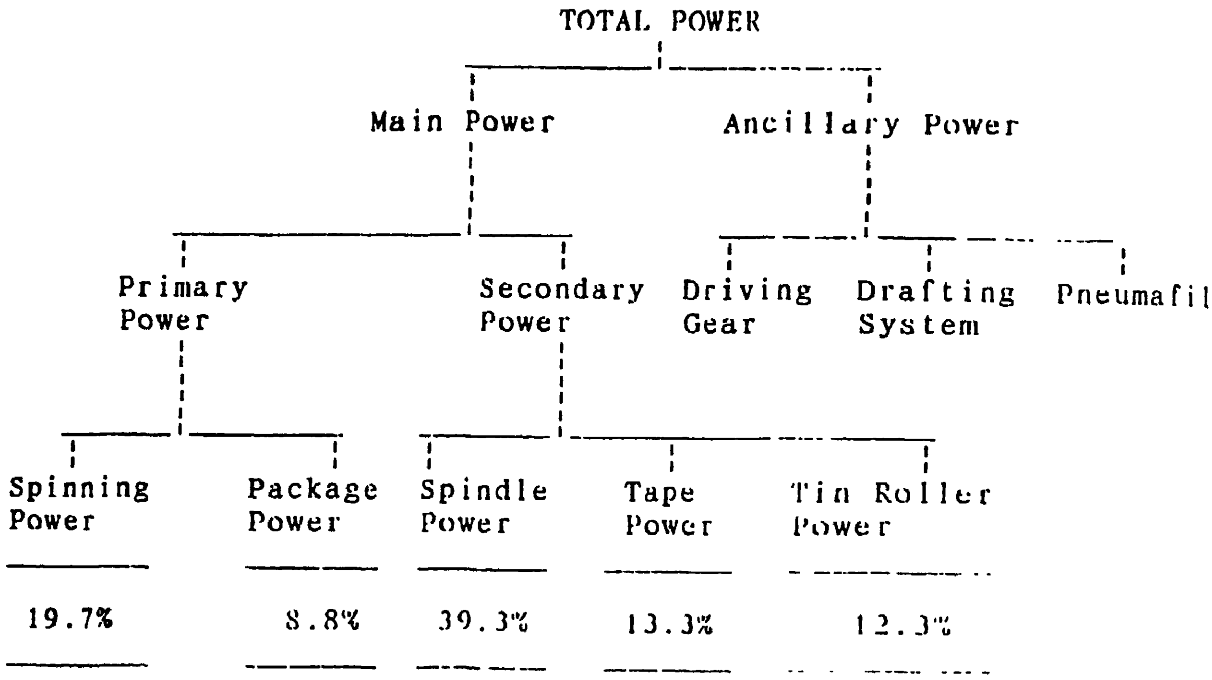
2. MOTOR MAINTENANCE

It was generally noted that in textiles motors maintenance is very much neglected. A basic maintenance programme involving periodic inspection and correction of unsatisfactory conditions will prolong the life of motors. To reduce the cost of maintenance is also equivalent to energy conservation. for example, motor cooling fans are chocked with the fluff so there is no cooling effect on motor. We will find motor will got high temperature and finally it will burn, also the hot motors increases the heat load of the department so more cooling power is required results extra energy consumption, motor efficiency will go down, etc. So every mill should have a practice to clean the motors frequently. There are other areas where maintenance needs attention i.e., motor terminal connection should be through terminal plate so that sparking can be avoided, fan cover should be properly fixed, bearing lubrication must be proper, if there is any bearing noise, the departmental people should immediately report to engineer for necessary action. Otherwise motor can be burnt any time, results lot of production loss and higher maintenance cost etc.

3. DETAILED ANALYSIS OF POWER

Firstly, we should analyse the percentage distribution of power, department-wise and details of power consumption in ring-frame component-wise because ring-frame alone contribute 55%-65% power of the total power in spinning mill.

RING-FRAME POWER CONSUMPTION COMPONENT-WISE



Note : The break-up values are based on the following :
Count : 40 Ne, Lift : 178mm, Ring Dia : 41.3mm
Spindle Speed : 10,000 RPM, Spindles : 400

It is clearly indicating that Ring-frame consumed maximum power so the maximum attention should be given to Ring-frame department i.e., proper cleaning of machine parts, proper alignment of pulleys, proper selection of motor, proper spindle tape tension, proper lubrication, suitable T.M. setting according to count etc.

4. POWER SAVING BY OVERHAULING

We got a complaint from particular mill stating that the 20 HP motor installed in one Ring-frame machine was burning out frequently whereas the same HP is running efficiently on other machines with the same count and same speed. From our experiments we found that the motor is taking more current than desired. We found that there is no damages to the motor which may cause over-loading. Then we analyse the machine sectionally and it was found that motor was overloaded due to bad maintenance condition of the machine. Results are as follows :

TABLE-3A : COMPARATIVE POWER CONSUMPTION BEFORE AND AFTER OVERHAULING

COUNT - 10 Ne

SPINDLE SPEED - 11,500

MOTOR HP - 20

	BEFORE					AFTER				
No.	Current	P.F.	KWH	Prod (Kg)	KWH/ Kg	Current	P.F.	KWH	Prod (Kg)	KWH/ Kg.
1.	20-25	0.85	14.6	23.3	0.627	18-24	0.85	14.8	26.8	0.552
2.	20-25	0.84	16.6	27.8	0.597	18-24	0.84	15.0	29.3	0.512
3.	20-25	0.85	16.7	25.3	0.660	18-23	0.85	16.2	29.5	0.553
AVERAGE SP.POWER CONS.					0.613					0.539

1. Saving of Power .074 KWH/Kg. OR About 12%

2. Yarn Breakage Reduced (From 45% to 20%) By About 25%

TABLE-3B : PART-WISE MACHINE LOAD ANALYSIS

ITEMS	LOAD IN AMPS.	
	BEFORE O.H.	AFTER O.H.
1. Motor No Load	11.5	11.5
2. Tin Roller + Spindle	16.0	14.0
3. Only Tin Roller	15.7	12.0
4. After Fluted Roller	16.0	12.0

TABLE-3C : EFFECT ON BREAKAGES

	Bkgs/100 Spdl. Per Hr.	F.R.S.	Spindle Speed	I.M.
Before O.H.	48.0%	230	11,400	4.7
After O.H.	16.2%	240	11,160	4.3

Details of Overhauling

1. Pulleys and shaft alignment setting.
2. Truing of tin roller.
3. Replacement of old bearings.
4. Freeing of jammed jockey pulley.
5. Tape tension adjustment by reducing tape length.
6. Fluted roller truing.
7. Spindle and lappet gauging.
8. Machine levelling.
9. Changing of spindle oil.
10. Proper lubrication of other parts.

From the above discussion it enlights the importance of maintenance of machines regarding conservation of energy. So the maintenance people should also aware of these things and thus must act as a helping hand to the engineering department.

TAPE SETTING

Here, we have reduced the length of spindle tapes by 4" to reduce air resistance and friction losses and thus the tension of the tapes also made perfect. The power saving due to tape setting is given below :

	Tin Roller + Spindle Load	Spindle Speed	KW/Hr	Idle Spindle	Saving (Kw/Hr)
Before Setting	16.5 Amps	13,300	5.6	4	-
After Setting	15.5 Amps	13,500	5.1	-	0.5

So the Saving due to proper Tape Setting will be = 0.5 KWH (Around 9%)

5. COORDINATION BETWEEN PRODUCTION AND MAINTENANCE

It is generally observed that the production and maintenance people tend to neglect the following important aspects and keep them at the mercy of Engineering Department like :

(i) Regular cleaning of motors, panels and machines etc.

(ii) Checking for overheating of motors/wires and connections.

(iii) Checking of alignment of pulleys, tightness of tapes, vibration of motors etc.

(iv) Proper relay-setting of motors and checking from time to time.

(v) Awareness with regard to power consumption in machines with regard to idling losses , low productivity, reduced down-time of maintenance etc.

The above points may look to be simple but if implemented regularly may lead to lot of improvement.

Some maintenance schedules of engineering items are given for the knowledge of maintenance people.

6. PROCESS OPTIMISATION IN SPINNING

During consultancy in a few cotton spinning mills, it was observed that there is a general tendency of increasing the spindle speeds in Ring-frames in order to achieve maximum production. But increase in spindle speed lead to increase in end-breakages rate and also mechanical breakdowns, wear and tear and the maintenance cost besides increasing the heat load, waste and hazards. In order to compromise with the increase in the end-breakage rate the mills generaly prefer to slightly increase the twist multiplier (T.M.). It was also noted that generally the mills do not analyse overall gain of the increased speeds in terms of saving in Cost of Production, some detailed experiments was conducted as follows :

The mill was spinning 20 Ne cotton in Ring-frame at a spindle speed of 12570 RPM at a TM of 4.47, the production was 26 kg/doff and UKG 1.17 as shown in Table 4. The spindle speed was reduced in steps upto 10700 RPM keeping front roller speed constant as before i.e. 196 RPM. Production remained constant being due to speed reduction and lowering of TM the power consumption drastically reduced from 1.17 UKG to 0.83 UKG i.e. a power saving of about 30% was achieved.

Quality parameters were also checked and it was found that there was no deterioration of your quality like CSP, End-breakage Rate, U% etc.

7. ENERGY EFFICIENT MEASURES FOR POWER

There are lot of new innovation and modifications in the machines which are energy efficient have been introduced i.e., conversion of cotton spindle tape to synthetic spindle tape of 10mm, lower wharve dia of 22.2mm and 20.5mm instead of 25.4mm, V-belt drive to flat belt drive, use of new version of spindle oil, etc.

(a) Replacing the cotton tapes by synthetic tapes there is reported to be a net power saving of 6% to 8%. Although the manufacturers claim 16% to 18% power saving but in actual practice considering cost of tape, long term effectiveness etc., the overall power saving remains around 6% to 8%.

(b) Changing of 25mm spindle wharve dia to 20mm or 18.50mm wharve dia. As per studies conducted by RA's there is a saving of 8 to 10% power, which is quite attractive. Since this requires huge investment, so mills should plan this measure during scheduled spindle change period on installation of new Ring-frames. Now-a-days special antivibration spindles are marketted by foreign companies which can give a very high spindle speed of more than 22000 rpm. These spindles give high productivity and lower energy consumption.

(c) Changing of V-belts of flat belts in Ring-frames has been reported to give around 5%-6% saving. But this has not yet been established in the mills because of certain technical problems.

(d) Use of polypropylene/polycarbonate bobbins which are lighter, smoother and longer lasting. These bobbins give about 2%-3% power saving.

(e) **Lubrication**

Better lubrication system can go a long way in giving reduced production cost, better quality, longer life of machines etc.

Better Version of Spindle Oil

Recent development in spindle oil characteristics have given rise to a new version of spindle oil which gives 4%-5% power saving and the oil life is more than one year. This oil is called Servospin EE 10 developed under a joint project of IOC-NITRA.

Overfilling of bolsters with oil is also a source of power consumption. It will be seen from the study that if oil content increases from 4.2 c.c. to 8.2 c.c. there is an increase in power

consumption from 3.53 KWH to 3.67 KWH i.e., an increase of about 4%. So optimum level of oil is about 2/3 to the height of bolster or 75% of total capacity of bolsters.

Similarly, excess packing of grease in tin roller bearing to avoid resistance to rotation and contributes to higher power consumption to the extent of 3% to 4%. IOC has developed multigrade grease which has longer life and can work athigh temperature.

8. CASE STUDY OF ENERGY EFFICIENT MACHINES

We are giving a Case Study of a mill which is quite energy efficient as they are using new energy efficient technology machine. In this machine the following power saving measures have been considered :

A. 16mm cotton spindle tape has been replaced by 10mm nylon synthetic spindle tape.

Advantage

1. Very low tape slippage results less TPI C.V.%, due to less twist variability strength. C.V.% is also very less.
2. Power saving upto 8%.
3. Less machine down time due to less tape breakage.
4. Less idle spindle percentage.
5. Long life of the tape, etc.

B. 25.4mm spindle wharve dia has been replaced by 22.5mm spindle wharve in all the machines.

(1) Power saving to the extent of 10% to 12%.

C. Flat belt is being used instead of V-Belts in all Ring-frames. This also results in some saving of power (3% to 4%).

D. The mill is achieving a very high spindle speed of around 17,500 to 18,000 rpm with the installation of inverter drive in the Ring-frame. As a result machine productivity is quite high i.e. around 85 gm/bobbin and due to this specific power consumption or UKG is around 1.60 as against 2.0 in conventional machines. So we can very easily say that there exists a scope of around 20% power saving by adopting energy efficient measures.

Now-a-days several electro-mechanical types of variable speed control devices are in the market which are also quite useful in getting higher spindle speeds resulting in higher productivity. Being cheaper option these are useful in limited way. Whereas inverter drives are costly but they can operate in wider range.

E. The machine has 576 spindles. 45mm ring and 210mm lift having very good productivity. The mill has very good yarn content on bobbin which is around 83 gms/bobbin, which is also very helpful for reduction in specific power consumption. Also it increases the winding efficiency, less doffing load, less machine down time for doffing, etc.

F. Individual suction tube is given for every spindle which gives very good suction. The suction pressure was around 18-13cm.

G. Mill is using newly developed SERVOSPIN EE 10 spindle oil with 5cc level. This oil is supposed to give long oil life & energy saving.

RESULTS

Out of these studies we found that in energy efficient machine the power consumption can be further reduced by some modification in the pneumafil suction fan. It was found that the weight of the impeller was around 13.5 kg. (cast iron) which is major drawback for higher power consumption. So it was suggested to replace it by Aluminium casting which will be around 6.5 kg. or mill can also try Nylon impeller having 3.5 kg. weight. You will be wonder after reduction of the weight from 13.5 kg. to 6.5 kg. the power saving is around Rs.3,00,000/- per year for all the ring frames while the casting cost will only be around 1/3rd of the power saving.

POWER SAVING BY MINIMISING IDLING OF MOTORS IN REELING MACHINES/BUNDLING PRESS

Generally motors of reeling machines run continuously inspite of the fact that these machines have hardly an efficiency of 20 to 25 percent i.e., 75 to 80 percent of the time motors run ideally. By providing a limit switch the motors can stop whenever machine stops, thus saving power and increasing life of motors, bearings, belts etc.

Same measure was applied to bundling presses also, in which limit switch was installed thus stopping the motors whenever motor stops.

9. POWER SAVING BY INTER CONNECTING PNEUMAFIL MOTORS WITH MAIN MOTORS

Power can be saved in Ring Frames by stopping the pneumafil fans whenever machine stops due to doffing, cleaning, etc. Also other advantages are increased life of fan motors, reduced heat load and reduction in wear & tear etc. One mill having 88 Ring frames can save more than 80,000 Units/Year.

10. POWER SAVING IN BUNDLING PRESS BY STOPPING IDLE RUNNING OF MOTORS

Limit switch was installed in Bundling Press to stop motor during idle periods which constitutes about 80% time thus apart from power saving motor life was increased.

11. POWER SAVING IN HUMIDIFICATION

(i) **Seasonal Control**

Lot of power can be saved by controlling speed of fans as per seasonal requirements. Mostly mills are doing this practice for winter months, but for intermediate periods like February to April, September to November, the fan speed should be reduced by variable pulley. Now-a-days inverter drives are being used for continuous speed control. This will give much greater energy saving.

(ii) **Day & Night Control**

In one mill by switching off 50% of Supply Air Fans & Return Air Fans the mill could save atleast 1,50,000 KWH of power per year. The inside DBT of Ring Frame section was only 90-92°F in the month of May during day time. So during the night period 50% fans could be switched off.

(iii) Use of Energy Efficient Monoblock Pumps in place of Old Humidification Pumps.

(iv) Energy Saving by Automation of Humidification System.

Automation of humidification system is available which can provide required humidity, air quantity as per seasonal changes mainly by damper control and in some cases motor ON/OFF. This does not give much energy saving. NITRA is working on system which can provide automatic control by sensing of humidity, temperature (inside & outside) and accordingly change the speed of motor by input control thus giving energy saving.

12. POWER FACTOR IMPROVEMENT AND PROPER UTILISATION OF CAPACITORS

Mill can achieve monetary benefits by maintaining a higher level of Power Factor i.e., around 0.96. One mill has achieved about Rs.82,000/- per year saving by improving PF from 0.92 to 0.96 thus reducing MD by 72 KVA.

The other advantages are :

(i) Improvement of system efficiency
(ii) Reduction of line losses
(iii) Less heating of panels, cables, etc.
(iv) Monetary benefit by way of rebate.

It is general practice in many mills to add more and more of capacitors for PF improvement, which is a bad practice. In fact PF should be improved by minimising overmotoring as far as possible. Standard capacity of capacitors should be maximum 35% to 40% of average electrical demand.

In one of the audit study, one mill was found to have capacitors as high as 80% of electrical demand. It was suggested to reduce the capacitors to 40% level thus saving about Rs.1,50,000/-.

13. POWER SAVING BY MINIMISING HIGH POWER CONSUMPTION OF CAPACITORS

In one mill the power consumption of capacitors was measured. It was found that 1,340 KVAR of capacitors were consuming about 50 KW of power which is very high.

Standard power consumption is around 5 Watt/KVAR as against 20 Watt/KVAR. The mill can save around 3,00,000 KWH/Year of power directory.

Now-a-days energy efficient capacitors have come in the market which consumes much less power. Most important thing is that the performance evaluation of capacitors should be carried out time to time.

14. POWER SAVING BY PROPER LIGHTING SYSTEM

Lot of energy saving can be achieved by adopting efficient lighting system and also by rationalised operation as given below:

(i) Use of energy efficient lights
(ii) Reducing excess lights/wastage of lights
(iii) Use of constant and light voltage
(iv) Maximum utilisation of day light

In general not more than 2 to 3% of total power should be used for lighting which in specific cases may go to as high as 5-6%.

TABLE-6 : POWER SAVING ACHIEVEMENT BEFORE AND AFTER ENERGY AUDIT IN A SPINNING UNIT

Month	Spindle Installed	Avg. Count	Production in kgs.	Spindle Shift Worked	Working Days	Total Power Consumption (KWH)	Specific Power Consumption UKG	Specific Power Consumption USS
				BEFORE IMPLEMENTATION				
July'90	16,256	31.70	1,97,913	14,60,100	31	7,62,588	3.85	0.522
Aug.'90	16,256	32.36	1,94,191	13,70,520	30	7,36,209	3.79	0.537
Sep.'90	16,256	33.08	1,94,914	13,71,060	30	7,39,824	3.80	0.540
Oct.'90	16,256	33.09	1,91,739	13,11,960	29	7,81,749	4.08	0.596
Nov.'90	16,256	30.50	2,05,020	13,89,960	30	7,87,287	3.84	0.566
Dec '90	16,256	29.56	2,11,784	13,78,167	31	7,56,536	3.57	0.549
				AFTER IMPLEMENTATION				
Jan.'91	16,256	31.80	2,01,597	14,33,967	31	7,07,239	3.50	0.493
Feb.'91	16,256	30.21	1,87,591	12,85,032	28	6,19,842	3.30	0.482
Mar.'91	16,256	29.77	2,05,536	13,63,050	30	6,98,749	3.40	0.512
Apr.'91	16,256	29.78	2,04,322	13,82,220	30	7,19,189	3.52	0.520
May '90	16,256	29.73	2,12,836	14,29,689	31	7,32,607	3.44	0.512

RESULTS ACHIEVED

	Total Power Consumption (6 months Avg)	Total Production (Avg.6 months)	Avg.count (6 months)	Working Days	Specific UKG	Power Consumption	
						UKG40s Converted	USS
Before Implementation	7,50,639	1,99,260	31.65	30.00	3.82	6.18	0.551
After Implementation	6,95,525	2,02,376	30.26	30.17	3.43	5.75	0.551

Some Recent Developments In Textile Chemicals Processing

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SOME RECENT DEVELOPMENTS IN TEXTILE CHEMICALS PROCESSING

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The latest developments in wet processing are based on the philosophies of economy, ecology, reproducibility and flexibility. Most of the developments are aimed for quality upgradation and to overcome the limitations of the existing technology. These developments are focused on better cost effectiveness via catering for quality and environmental considerations. Textile wet processing can be broadly classified in four sections viz., preparatory, dyeing, printing and finishing. The recent developments cover, aspects, like process developments, machinery developments, dyes, auxiliaries and product developments. Owing to the increasing influence of the concept of globalisation implemented with the awareness in the arena of eco-friendly products, Indian textile industries are facing stiff challange on domestic as well export front.

The developments in wet processing, in view of the above facts, gain significance in the following areas :

1. Minimum load on effluent
2. Conservation of energy and water
3. Consistency of processes
4. Combination of processes
5. Shortening of cycle time
6. Higher productivity
7. use of micro-processors and computers
8. Minimisation of cost of production
9. Use of safer chemicals
10. Alternate chemicals and dyes as a replacement of banned chemicals and dyes.
11. Developments of dyes, chemicals and safer process
12. Searching for new technology and their application.

Overall attention has been paid to following areas like :

1. Process development
2. Machinery development
3. Recycling of waste heat
4. use of non-conventional sources of energy

Now a days thrust is on energy saving by adopting several measures and techniques. Process houses consume about 50% of the steam. Since textile goods are subjected to wet treatment 3 to 4 times and every time they require heat to evaporate the water. Hence, steam consumption depends upon the process resources and water content. (Annex-I : Norms for specific steam consumption). Similarly energy requirement also depend on the type of machine used (Annex-II, Table A & B). The consumption pattern of water is given in Annexure-III.

Optimum heat stabilisation can be affected by :

1. Fuel & Waste quality
2. Reduction in use of water
3. Fuel utilisation of steam
4. Fuel quality
5. Steam pipe line, location of boiler, outlay of pipe line, leakage, lagging etc.
6. Process development
7. Machinery development
8. Machine utilisation
9. Production planning

Besides utilisation of waste heat is another important measure where large quantum of waste energy can be used.

As such a general guideline of process matter is given here to show the energy requirement in different areas like :

Process	Temp. for all cotton	For Synthetic & Blended
Desizing	40°C - 60°C	50°C - 60°C
Scouring	120°C	Around 100°C
Bleaching	35°C - 49°C (Hypochlorite) 90°C - 95°C (Hydroxide)	90°C - 95°C (Puraide bleaching).
Dyeing	40°C - 95°C	120°C - 135°C
Washing	90°C	90°C
Drying	140°C - 150°C	140°C - 150°C
Finishing	150°C	150°C - 160°C
Heat setting	-	190°C - 220°C

Wet processing of textile material are being processed in three different forms like :

1. Fabric 2. Yarn 3. Fibre

In this paper few latest technologies are described on fabric and yarn processing where besides productivity, energy saving potential are there.

Preparatory is the first step in textile processing which includes a) Desizing, b) Scouring, c) Bleaching and d) mercerization. The basic purpose of fabric preparation is to remove all natural and added impurities, and make the material ready for subsequent processes like dyeing and printing.

Various attempts are reported towards combination of processes, single step process, shorter duration, recovery of sizing chemicals, and cold process. Some of the developments are listed below :

1. Single step desizing, scouring and bleaching
2. Single step scouring and bleaching
3. Cold and warp scouring and bleaching
4. Recovery of polyvinyl alcohol sizing for their re-use

5. Application of enzyme for scouring

6. Mercerization of knit goods

Developments in the preparatory area

There are various developments in the preparatory area. Some of them are :

<u>Singeing</u> :

On the Parex Mather MK 9 model valve has a digital display to ensure rapid, reproducible flame settings. The twin-crossed flame burner and the patented cloth threading arrangements form a singeing pocket, the size of which can be adjusted by upper roller. Optimal singeing can be achieved by tilting the burner angle in relation to cloth position. as per process requirements.

In vari-jet singer from Osthoff-Senge fabric is de-twisted and opened to full tubular width using ring openers. It is then passed over a special race-track-configured metal opening device supplied in various widths. The vari-jet then applies a singeing flame via two linear burners and two semi-circular burners to cover the shole surface of tubular fabric. A novel and innovative feature for flame control of dual burners is the use of a touch key pad "intelligent" singeing system. This sets all settings for different fabrics automatically.

<u>Single Step Scouring & Bleaching</u> :

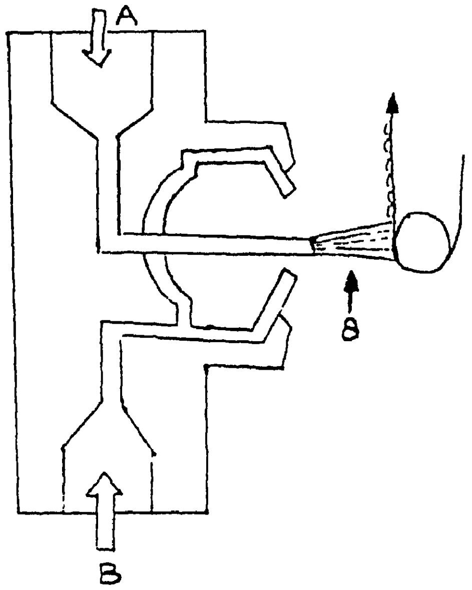
For chemical pre-treatment of woven cotton and PET/Cell, blends fabrics some new continuous ranges are - Benninger Ben - Injecta Compact lower water usage, intensive washing system, Burgman Brugo-matic bleach range and Ramisch - Kleinewefers Raco-yet system.

<u>"Raco-yet" Application Technique</u> :

This development comprises de-sizing, boiling-off and bleaching processes in one single operation with a pre-treatment time of 1-3 minutes.

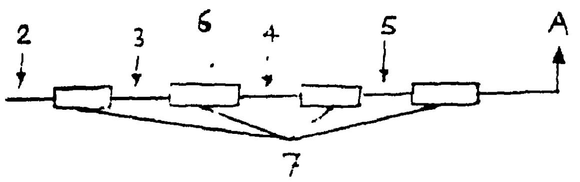
<u>Principle</u> :

The "Raco-yet" system consists of a heated aerosol of water vapour and chemical liquor being formed and introduced into the fibre structure and the capillaries of the textile substrate, whereby the chemical and thermal energy can act simultaneously. In order to produce this aerosol, a nozzle system used in the form of a two-fluid mixing nozzle with external mixing.



A: Feed of water and chemicals

B: Feed of steam



Single component dosing system :

1: Water
2: Silicate of soda
3: NaOH
4: Cottoclarin AS
5: Hydrogen Peroxide
6: Weight proportional chemical dosing
7: Mixing pipe, change of recipe below one minute
8: Application of liquir is adjustable within a wide range.

The individual two-fluid mixing are arranged on a beam system and mounted in such a way that the individual flat spray sets overlap in order that a uniform liquor application over the fabric width is ensured. In "Raco-yet" system desizing does not depend on the type of sizing agent. Both systems i.e. dry-on-wet and wet-on-dry can be used effectively. Fabric processing range is from 80-400 gm/sq.m.

Advantages :

The advantages of the "Raco-yet" system are :

* Increase in efficiency
* Only two minutes dwell time allows better quality of fabric
* No more crease marks
* Yarn dyed fabric can be pretreated, no stains
* Very good degree of desizing 6-9 according to Tegewa scale
* Very good absorbency
* High degree of whiteness 80.3
* Better tendering factor (average only 0.2-0.3)
* The fabric has a softer and fuller effect
* No mercerization for dye-pickup required
* All above mentioned effects are uniform and reproducible
* Only one washing stage i.e. only 6 lit/kg water consumption
* Only one steaming stage i.e. only 0.4 kg/kg steam consumption
* Low liquor losses only 7%
* Less personnel required (1-2 only)
* Fabric independent pick-up reliability

Mercerising :

Kusters has developed a Flex-Nip impregnation system for the application of caustic soda to the fabric. The caustic soda liquor circuit has been decreased to just 200 lit. After passage over a chainless zone the fabric is squeezed and then tensioned over rollers in the length stretching zone. Then the fabric is passed into the washing and drying zones. The Kusters Ecomerce unit is a compact mercerisation system capable of a high degree of fabric and process control.

Washing Machines :

A wash off line for woven and knit goods consists of a combination of perforated drum washing machine, spraying compartment and dwelling bath for delicate material of cotton, rayon and synthetic fabrics.

Convitex C vertical washing machine is having the use of spray lines instead of conventional squeezes for bath. Other features of this machine are :

* Hydro mechanical effect guarantees the rapid removal of substances from fabric.

* For knits, fabrics run in rope form to give better relaxation; cost effective and environmentally friendly.

Developments in Dyeing technology

The areas covered under this section are :

1. Developments in dyes

2. Developments in machinery

3. Developments in Dyeing methods

4. Electronics and software application

The technical developments in the dyestuff industry are taking place from the view point of :

The technical developments in the dyestuff industry are taking place from the view point of :

i) High performance products i.e. concentrated brands and non dusting brands.

ii) Cost effectiveness i.e. due to increased automation, advance instrumentation and controls, and computerization for manufacturing operations.

iii) Health, safety and ecology aspects i.e. avoiding the use of dyes which can form on reduction carcinogenic amines and selection of high exhaustion/fixation reactive dyes.

The developments in the field of new dyes of disperse and reactive types are briefly dealth below :

New disperse dyes developed of benzodifuranone class having high colour value, brightness of shade, good substantivity and low thermo-migration. some of the new disperse dyes available are :

* Resoline Brilliant Red F3G5 (Bayer) - Suitable for thermosol process.

* Palanil Blue 3GFN (BASF) - Suitable for PE blends and insensitive to dyebath pH and reduction; good fastness to heat-setting.

* The dispersol XF and dispersol SF from ICI are benzodifuranone based dyes.

  There is a upward trend in reactive dyes application for cellulosics. Recently, a new generation of bi and poly-functional dyes consisting of homo and hetero reactive system have been introduced. some of them are :

* Sumifix Supra Range (bifunctional) has high degree of exhaustion and fixation resulting in high light fastness, perspiration and peroxide washing.

* Cibacron C range dyes (Ciba-Geigy) are bifunctional dyes which have an aliphatic vinyl sulphone group combined with either a monofluorotriazine group or an aromatic vinyl sulphone with the following features :

  1. Suitable for pad application and exhaust dyeing at low liquor ratios.
  2. Excellent wash off
  3. High levelness
  4. Water and energy saving due to easy wash off.

* Zeneca's procian H-EXL exhaust dyes (bifunctional) with high performance level dyeing, migration, diffusion and exceptional build up properties.

New Remazol EF (Hoechst) dyes :

- require 33-70% less salt than the conventional reactive dyes

- safe packaging (low dust powders or liquids)

Developments in application methods

Polyester Fibres :

Recently Hoechst Mitsubishi Kasei (HMK) has developed a new system i.e. dyeing of polyester in an alkaline medium thereby making the entire wet processing simple and reproducible. The quality of the dyed material is also improved. And the problems due to the presence of polyester oligomers in acidic dyeing conditions are also minimized.

The HMK system involves both alkali-resistant dyes and newly developed multi-functional stabilizer JPH 95 for dyes in alkaline conditions. This stabilizer maintains dye bath pH around 9-9.5 during dyeing. The small variation in pH during dyeing cycle promotes excellent reproducibility.

Developments in Dyeing Machinery :

Dyeing knitted fabrics, microfibre fabrics and their blended fabrics, and easily creasable fabrics require more gentle handling. In Jet dyeing machines, fabric speed is high and causes fabric abrasion. In overflow system, fabric is propelled by the overflow liquor only without dynamic pressure. In soft flow system, a part of liquor is replaced by air, giving a loftier fabric and a highly ecofriendly dyeing. PTFE coating of inner surface is carried out to reduce frictional drag. Liquor ratios used are 1:4 to 1:6 irrespective of load. Soft flow machines from Sclavos, Greece, having so many varieties according to fabric type and fibre nature. TSF versions having facility of microwash with dual nozzles. AD-44 is based on 'ballooning system", so provides the fabric a more gentle movement without creasing.

In the field of Jigger dyeing, there are so many developments. Some of the main features are as :

* Computerized operation
* Electronically driven
* Hydraulic drive
* Wide range of fabric to be processed i.e. from silk to heavy cotton fabrics
* Auto dosing of dyes, chemicals and draining of bath
* Liquor circulation and equipped with thermoregulator for progressive heating of dye bath to get uniform dyeing
* Service tank facility
* Vacuum suction system (as in Fong's vacuum jigger)

Developments in Finishing :

The areas are :

1. **Wet on wet system through automater**

2. Development of eco-friendly chemicals

3. Mechanical finish

4. Knit wear finishing machines

5. Machinery developments

There are also many developments in the mechanical finishing area. Some of them are :

(a) Krantz Open Width Compactor (Microk system), is designed for compressively shrinking jersey, pique, interlock and fleece fabrics, the weft knitted fabrics, supported by plasma-coated main roll, is conveyed into a converging passage, firmly gripped and pasted into a treatment cavity, where the compaction takes place. On the under side of tungestan carbide-coated retarder are photo etched micro-grooves, hundreds of individual treatment zones are passed against the fabric, the retarder being forced downwards by the action of the pressure plate, operating against the spring like action of the walton curve pressing against the back-up component in the contact with the retarder. This gives a uniform and even fabric compaction.

(b) Shrink dryer by Krantz not only dries, but also controls shrinkage, develops volume and improves feel in its tumbling zone. Fabric is fed at low tension onto a screen belt with an adjustable high overfeed of upto 200%. Drying is carried out continuously by hot air in either of two modes - rebound set or permeation drying. This semi-dry, preheated fabric is then dynamically moved by a special circulating air control system. The speed of this tumbler process is adjustable according to the finish.

(c) <u>R.F. Dryer</u>

R.F. dryer is the 'controlled drying' system, manufactured by Procter Strayfield Ltd., England. They promoted the Fastran "cool dry operation" which is suitable for drying loose material, yarn hanks, tops, tow and hosiery. In the cool dry system an air/vacuum arrangement allos drying at less than 60°C, automatic speed control eliminates problems of overdrying and yellowing. Other features are;

* Fully computerized control system
* Dries fibres at correct drying temperature
* Eliminates dye migration
* Labour reduction/saving
* More productivity (30% increased over conventional drying)
* No noise
* No loss of energy by radiation.

General trends in developments of yarn processing:

The areas where development has taken place are given below : Development in Rapid dyeing process

- Packaging system
- Low liquor ratio approach
- Drying system
- Automation and handling technology
- Proper selection of dyestuffs

The development of Rapid dyeing process is possible by accelerating the rate of liquor flow by high capacity pumps and fast heating rate. But in this system, there is a limit due to possibility of yarn damage & deformation.

The low liquor ratio (1 : 4) technique having minimum amount of liquor and maximum machine load. This technique reduces energy cost and effluent load. However dissolving of dye powder may give some problem. Hence, now a days universal dyeing machines are manufactured which are useful for low and high liquor ratio. The machine " Super Flux NE " manufactured by ATYC based on " Optimised differential measuring " system which is controled by variable pump drive.

For efficient dyeing process differential pressure should be 0.4 Kg/cm to 0.8 Kg/cm depending upon density of packages. In the series of process control, the system from Thies" pH-FIT" can be used for pH controled dyeing.

An important development in yarn dyeing is auto dispensing system (Fig.1). This technology permits automatic metering- in of substances e.g. alkali & salt addition in case of Reactive dyeing process. An example is given from the field of reactive dyeing on cellulose, showing data processing programs for the "Levafix" dyes LEV1 and LEV2 from Bayer and for "Drimaren" dyes DREAM K and DREAM X from Sandoz.

The process "Remazol-automet" from Hoechst includes progressive dispensing of alkali. Like Then, other machine manufacturers too have a licence for this process.

For Indanthren dyestuffs on cellulose BASF offers "RAISA 1" and "RAISA 2".

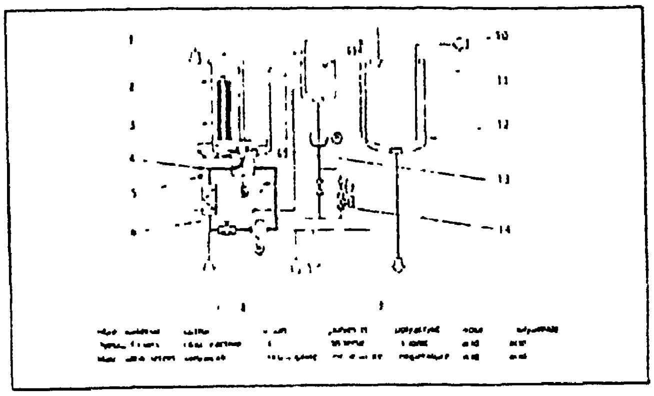


Fig.1 : Shows Dispensing System

1 Vessel pressure
2 Temprature
3 Differential pressure
4 pH value
5 Temprature
6 Liquor throughflow
7 conductivity
8 Frequency control
9 Water counter
10 Level measurment additional tank
11 Level measurment secondary tank
12 Temprature
13 Level indicator
14 Dispensing of chemicals

In complex shades proper dye selection is also an important factor. It affects quality of dyeing so dyes of same dyeing behaviour should be mixed to get uniform dyeing . The dyestuffs which can give higher yield should be used.

The drying process of yarn is of the great importance both economically as well as qualitatively. The numerous materials and the various types of make-up of the yarns demand optimised drying processes and increase use of control and automation system.

Process Flow in Yarn Processing:

The flow of yarn material may vary on its use or process area (i.e. mill sector or decentralised sector).

Package Dyeing:

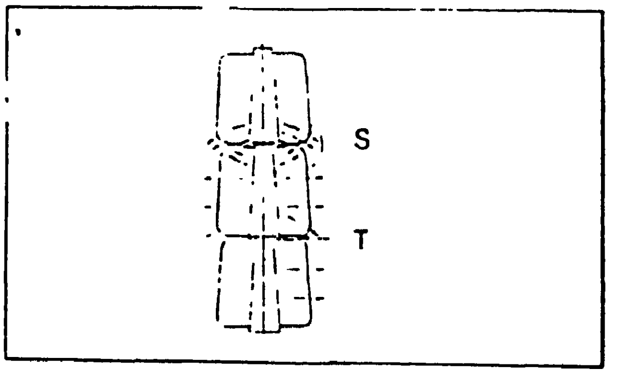
In this system yarn dyeing is carried out on conical or cylindrical cross wound packages i.e. cones and cheeses. Process Flow of material will be -

```
                                   Dyeing
Packages-->Scouring-->Washing <              --> Hydro      ---->Drying
                                   Bleaching      extraction       |
                                                                   v
                                                               Off Winding
```

Recently disadvantages of cones and benefits of cheeses have been reported.( ) The disadvantages of cones are as follows:

- Uneven flow of liquor through wound package
- Low material in lots
- Losses through the leakages
- High labour costs for loading & unloading the carriers
- Unsuitable conditions for automation implementation of loading/unloading.

Cylindrical press-loaded cheeses overcome these difficulties. These cylindrical tubes having triangular perforations. In case of large wound cylindrical cheeses pressure distribution remains more uniform. Star type spacers also eliminates uneven flow of liquor through packages as shown in Fig.2.



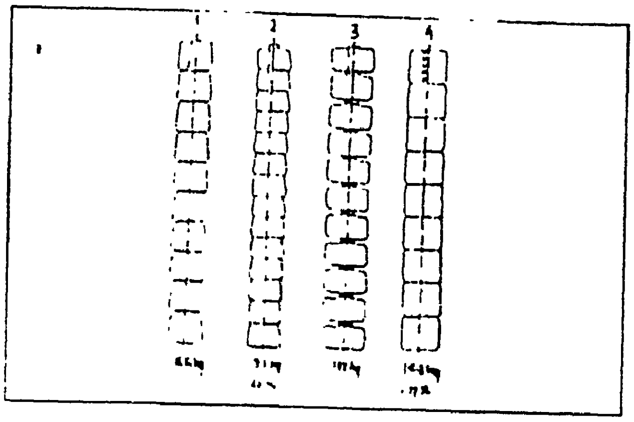
Liquor flow in a cone column with & without star spacers

S - Uneven flow

T - Star spacer

The telescopic type cheeses and cones were a considerable improvement. In this system cones are pressed in the form of column using press-loading system. With this system, higher

production can be achieved. The low liquor ratio saves water, heat energy, auxiliaries and dyestuff. Load comparison is shown in Fig.3.



Comparision of different types of tubes

1 cross wound package

2 cross wound package with telescopic tubes

3 CE packages with rigid tubes

4 CE packages with plastic tubes

As diameter of package increases, the transportation channels (micro-channels) must get longer and density should be reduced. For resistance characteristics, yarn construction, the substrates and swelling and shrinkages behaviour of fibres plays key role.

<u>Innovation in yarn drying system</u>:

Basically, there is a choice of four systems -

- Drying by evaporation
- Hot air forced draught drying
- Combination of these two
- High frequency drying (RF drying)

Economic drying of textile material depends upon proper dehydration (e.g. hydro-extraction). In few years, main attention paid to good insulation of dryer, control of exhaust air and recuperation of the heat from the exhaust air.

Quality of yarn during drying is not adversly affected. The quality of yarn should be as follows:

- No deformation of yarn package as well as smoothness of yarn must be retained by use of finishing agent otherwise it will create more resistance in off-winding and running affect knitting machines efficiency.

- No dyestuff migration.

- No yellowing of material.

- No detoriation in strength & elongation of yarn.

- Even drying i.e. Residual moisture in all packages as well as within the package should be same.

(A) Drying by Evaporation:

The cabinet dryer, circulatory dryers, Tunnel dryer, belt dryer and high frequency dryers fall in this catagory. These are suitable for packages, ropes, muffs & hanks. The energy cost is low due to circulating air technique. Tunnel dryers are suitable for Hank drying or rods. Sometimes rods are in rotating position to avoid rod marks and moisture migration. Super heated steam (steam content 75-90%) drying gives highest heating up, excellent conditioning with high post steam and highest decrease in fibre swell reaction.

In textile industry high frequency (RF) drying is the latest technique with wider application. The properly hydro-extracted material is placed between two condensor plates and traversed by high frequency altering current. The heat is produced into the material itself. The drying process lies mainly in its removal. This technique is profitable in those areas where moisture content of material is reduced below 50% by mechanical extraction. In case of cotton it is not possible, so gives less efficiency.

Advantages of this system are :

- Short drying time

- Flexibility in material to be dried

- No influence of batch size

- Evenness in drying off within and inside of package as well of each package.

- Adjustable final moisture control

- Gentle drying process

- No heat loss due to radiation

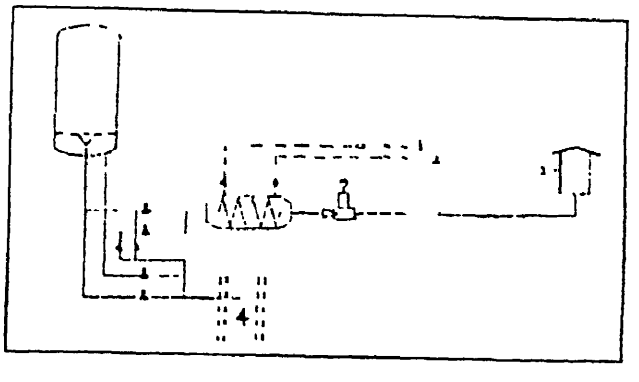
Disadvantages :

- High energy cost
- Exclusive use of synthetic yarn carriers
- High capital cost

(B) Package Dryers:

These dryers are based on circulation of heated air under atmospheric pressure or a pressure 4-6 bar. The air is heated through heat exchanger and then passed through packages (i.e. textile material). The flow of hot air kept outside/inside at start and finally reversed to balance the residual moisture in material. In Rapid dryers, exhaust air is evacuated into the outside air/room air, so heat loss occured which leads to high steam consumption. But it could be eliminated by a heat recovery plant.

These type of dryers has advantages over other evaporation dryers in terms of handling, short drying times, permitting higher production. But there is a risk of dye migration in some class of dyes. In case of pressure dryer exhaust air is extracted in a cooler and after water separation, re-heated which leads large heat energy & higher productivity. Schematically diagram of Rapid dryer is shown in Fig. 4



Rapid package dryerschmatic diagram
1 steam 3 air
2 condensate 4 water seperator

Table-II:Comparison of power consumption of various types of dryers

	H F Dryer	Hot Air Rapid Dryer	Circular Pressure Dryer	Vacuum Dryer	Chamber Dryer with Heat Recovery System
Electric Energy (kWh/kg)	0.68	0.60	0.30	0.3	0.02
Heat Energy (kg steam/kg)		1.7	1.2	0.3	0.03
Cooling Water (l/kg)	3.0		10.0	7.0	
Compressed air (m^3/kg)			0.03	0.04	

Table-III : Drying times for various drying systems

Drying time in min	Chamber dryer	Hot air rapid package dryer	Pressure dryer	Vacuum dryer
Cotton				
normal package	720...840	150	45...60	75
compressed package	720..1440	210	60...90	60
Wool				
normal package	480...720	120	45...60	75
compressed package	720...960	180	60...90	60
PES texturized				
normal package	240	40	20	25
compressed package	480	40	20	25
PES fibre yarn				
normal package	360	60	40	30
compressed package	600	60	50	30
Acrylic				
normal package	240	50	40	30
compressed package	480	50	40	30

In Table-III drying times for different systems are compared. For HF/RF dryers no comparison is given due to following factors:-

- Uncertainity of material to be dried per hour.
- After extraction, how much moisture is present in the material.
- Requirement of final moisture content.
- Machine installation capacity (in KW).

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Eco-Process and Environmental Standards in Textile Mills/Plants

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ECO-PROCESS AND ENVIRONMENTAL STANDARDS IN TEXTILE MILLS/PLANTS

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Textile exports, accounting for about 33% of Indian aggregate exports, emerged as a star performer both in terms of high volume of exports and enhanced unit value realisation. The highly quality conscious Europe is the largest importer of Indian Textiles and accounts for about 38% of total Indian export market. India is also one of the big producers and exporters of quality fibre and yarn. Among the items of textile exports, garment exports play a crucial role as they account for a lion's share of textile exports and a top foreign exchange earner for the country. Its share in total exports from India is over 16%.

In the present conditions of growing ecological consciousness, the textile and textile products are an extremely important sector which attract environmental consideration. Apart from this, eco-quality management will become an important issue to ISO-9000.

'Eco-labels' for clean garments have been introduced by most of the European countries, specially Germany, which could well constitute possible trade barriers, a major threat facing the Indian export industry. 'Clean Processing' too could soon become a requirement for export markets with importers integrating eco-labels as part of their general buying condition. There are several product related standards stipulated for textiles, as shown in Annexure-1.

The principal business groups affected by these eco-standards include-

1) Garment manufacturers & exporters.
2) Organised sector with large composite spinning & weaving mills.
3) Decentralised sector with the main share of wet processing & dyeing.

In the present Indian context, after the imposition of ban on the use of red-listed chemicals & certain specific class of dyes, it needs serious attention for the substitution of banned chemicals/dyes by the use of non-toxic ones.

Considering the banned dyes which are liable to release toxic arylamines on degradation, it is pertinent to have a critical analysis of dye-stuff according to the type of textile processing.

TABLE - I

S.No.	Type of Dye	Textile Material
01.	Acid Dyes	Materials having peptide or amide linkage like silk, wool & nylon etc.
02.	Direct Dye	Cotton
03.	Basic Dye	Acrylic
04.	Azoic Dye	Cotton
05.	Sulphur Dyes	Cotton
06.	Vat Dyes	Cotton,silk
07.	Disperse Dyes	Polyester
08.	Reactive Dyes	Cotton, silk
09.	Mordant and metal complex dyes	Wool, silk, nylon

Various eco-friendly standards like M.S.T., Eco-Tex-100, clean fashion, Steilmann are already enforced for strict adherence of critical tolerance level of 52 red listed chemicals as shown in Annexure II & III.

Further more, consumer goods ordinance promulgated in the German legislation banning the use of all benzidine base dye-stuff which are liable to release toxic arylamines is going to be enforced from 01.01.95, as far Indian textile export is concerned. The prohibited list of dyes includes 26 acid dyes, five azoic diazo component, three basic dyes & mostly direct dyes (about 76) and six disperse dyes. This may affect Indian export specifically from the decentralised sector unless viable alternative eco-friendly dyes are substituted for the prohibited dyes with immediate effect.

Especially the following articles are affected by this legislation:

- Garments
- Home textile (bed clothes & to web)
- Leather clothing
- Other clothing
- Upholstery fabrics
- Seat covers, children Seats
- Shoes belts
- Other like watch straps, frame for glasses, wings, bandages and covers for sports equipments.

EFFECT OF BAN ON PESTICIDES AND OTHER PROCESSING CHEMICALS

For grey cotton, in order to protect them from insects and fungi, a huge quantity of pesticides is being used in form of insecticides, herbicides and fungicides. These chemicals are very toxic, hence now-a-days attempts are being made to use organic fertilisers and biodegradable pesticides/herbicides.

However, the later process is much conslier and not practised in general. The main objection in this area is the use of pentachlorophenol (PCP) which is however now banned in several countries including India.

The cotton fibre always contains some residual pesticide which can be removed during scouring process. However, in case of grey yarn export this is not possible.

Therefore cotton pre-treatment process requires repeated washing for complete removal of such chemicals.

In bleaching, use of chlorine and bleaching agents has a severe objection as high residual chlorine is not allowed in effluents. Here, bleaching by hydrogen peroxide could be used as an alternative.

Other objectionable chemical is the presence of free formaldehyde, which comes from some of the finishing chemicals used. Now-a-days, research is well in advance to finish the textile goods with non-formaldehyde finishing agents. As far as Indian cotton goods for export are concerned, they are as a rule, not finished by any formaldehyde based resins, hence chances of rejection due to this reason are very scarce.

The other areas like flame retarding finishing chemicals are not very common in Indian textile finishing and hence not a matter of much concern.

Hence, the main threat is from the dyeing/printing area, where several benzidine based dyes and auxiliaries having metal content are being used. These banned dyes are suspected of releasing highly toxic arylamines on exposure of dyed fabric to sunlight for prolonged periods. These prohibited amines are known to cause skin allergies and are also carcinogenic in nature. These red-listed dyes/chemicals have to be identified and replaced accordingly as discussed in detail below, according to the type of fabric/fibre being processed. (Annexure-4)

IMPACT OF BAN ON DIFFERENT CLASSES OF DYES ON INDIAN EXPORT SCENARIO:

COTTON DYEING

As far as the dyeing of cotton is concerned, there are a number of dyes which could be employed for this purpose. The most commonly used in the organised sector is reactive dye which is exempted from the banned list of dyes. The banned list contains a wide spectrum of direct dyes. Direct dyes despite having its poor fastness properties are often used in combination with reactive dyes for the production of desired color shade. The use of direct dyes could be discontinued through proper replacement by the reactive dyes, which is having better light & washing fastness and abroad spectrum of colours. Similarly vat dyes through costlier could find an easy application as an immediate necessary solution. Azoic dyes which are having application both for dyeing and printing in the organised sector, similarly needs a suitable substitute.

SILK DYEING

Another important sector which will be affected by the ban is the silk goods, as acid dyes are having ample application in this area.

Among the banned list, acid dyes constitute a sizeable proportion. Such dyes are extensively used in silk dyeing. The elimination of selective class of acid dyes needs a judicious application of reactive, vat and natural dyes as a better substitute with the help of relevant mordants.

POLYESTER DYEING

POLYESTER is usually dyed using disperse dyes. As seen in Table-II, about six disperse dyes (mainly yellow & red colour) have been banned, for which suitable combination of dyes, not having the banned chemical group, could be substituted.

ACRYLIC DYEING

A few basic dyes are in the banned list but having insignificant effect as they are used in the acrylic fibre dyeing, an area which does not have a prospective export market under present conditions.

WOOL DYEING

Although wool is being dyed by acid and metal complex dyes. However, export of wool is not as significant as silk. Hence, the ban on acid dyes may not have immediate impact on export front.

Similarly to produce eco-friendly product, some substitute chemicals to be used in place of banned chemicals. (Annexure-5) The manufactures should be aware about waste water generated and tolerance limits for effluent discharge. (Annexure-VI & VII)

ANNEXURE-1

LIST OF ECO-STANDARDS FOR TEXTILES

German Development Institute, Berlin

The following standards are introduced by private organisations and companies to give information to the consumer or as part of general buying conditions, Governmental regulations may follow these standards in medium terms as the German parliament has already established a commission working of environmental impacts and damages to health of textile production.

Items	M.S.T	Eco-Tex	Clean fashion	Stelimann
free formaldehyde	0.03%	300 ppm	0.03%	500 ppm
- close to skin	0.0075%	75 ppm	0.0075%	300 ppm
- baby clothing	0.002%	20 ppm	0.002%	50 pmm
Pesticides	1.0 mg/kg	-	-	-
DDT	0.5 mg/kg	-	-	-
HCH	1.0 mg/kg	-	-	-
Lindan	1.0 mg/kg	-	-	-
Alfrin	0.2 mg/kg	-	-	-
Dieldrin	0.2 mg/kg	-	-	-
2.4-D	0.2 mg/kg	-	-	-
2,4,5-T	0.05 mg/kg	-	-	-
Toxaphen	0.1 mg/kg	-	-	-
Sum parameter	1.0 mg/kg	500 m	1.0 mg/kg	1 pmm

Contd..

TABLE-II

PCP	0.5 mg/kg	-	0.5 mg/kg	Prohibition
Heavy metals	0.01 mg/kg	-	-	Prohibition In silk Products
Pb	0.04 mg/kg	-	-	-
Cd	0.05 mg/kg	-	-	-
Hg	0.001 mg/kg	0.1 ppm	0.1 mg/kg	-
Baby clothing	0.001 mg/kg	0.02 ppm	0.02 mg/kg	-
Ni	0.2 mg/kg	10 ppm	10 mg/kg	Special(*)
Baby clothing			1 mg/kg	-
Cu	3.0 mg/kg	100 ppm	50 mg/kg	-
Baby Clothing	3.0 mg/kg	30 ppm	10 mg/kg	-
Cr III	0.1 mg/kg	20 ppm	20 mg/kg	-
Baby clothing	0.1 mg/kg	1 ppm	1 mg/kg	-
Co	0.2 mg/kg	20 ppm	-	-
Baby Clothing	0.2 mg/kg	1 ppm	-	-
Zn	5.0 mg/kg	-	-	-
Azoic dyes Containing Cancerogenic Aromatic Amines(**)	-	-	Prohibition	Prohibition
Halogenic carrier	-	-	-	Prohibition
Chlorine bleaching	-	-	-	If possible not

M.S.T. "Markenzeichen schadstoffgeprufte Textilien" (label for tested eco friendly textiles), a label that will be introduced by the German textile industry.

Contd..

Eco-Tex Standard	Standard set by an Austrian textile research institute. Some German and European buyers already change their buying conditions according to this standard.
Clean fashion	Criteria as part of buying conditions given by one of the worldwide biggest wholesalers
Steilmann	Biggest German producer of garments.

(*) Specification, if the eluation of nickel is higher as 0.5 ug/cmw^2/week

(**) According to the MAK-list (max. working place concentration)

ANNEXURE-II

II. LIST OF BANNED AMINES

DEFINITELY CARCINOGENIC IN NATURE

1. Benzidine
2. 4-Chloro-o-toluidine
3. 2-Napthylamine
4. 4-Aminodidphenyl

REASONABLY SUSPECTED TO BE CARCINOGENIC

1. 3.3' Dimethyl benzidine
2. 3.3' Dimehtoxy Benzidine
3. P-Chloroaniline
4. O-Toluidine
5. 3.3' Dichlorobenzidine
6. O-Aminoazotoluene
7. 2-Amino-4 nitrotoluene
8. 4-Methyl-1, 3-Phenylenediamine

OTHER PROHIBITED AMINES

1. 4-Methoxy-m phenylenediamine
2. 4.4' Diaminodiphenylmethane
3. 3.3' DDimethyl 4.4' Diaminodiphenylmethane
4. 2 Methoxy-5-methylaniline
5. 4.4' Methylene-bis-(2-chloroaniline)
6. 4.4' oxydianiline
7. 2,4,5-Trimethylaniline
8. 4,4' Thiodianiline

Contd..

DYES FORMING FOLLOWING AMINES ON DECOMPOSITION ARE TO BE PHASED OUT

1. P-Amino-azobenzene

2. 2-Methoxyaniline

LIST OF BANNED DYES

CLASS OF DYES	NO. OF BANNED DYES
Acid dyes	26
Azoic dyes	5
Basic dyes	3
Direct dyes	77
Disperse dyes	6
Oxidation Base and Developers	1
Total	118

The above dyes release the 20 (forbidden) carcinogenic amines on reductive cleavage of the azo group.

ANNEXURE-III

List of toxic and harmful substances used by Textile Industry

S.No.	TEXTILE PROCESS	TOXIC SUBSTACNE USED
1.	a. Cotton Growing	Pesticiddes like DDT, Dieldrin, Aldrin etc.
	b. Manufacture of man-made fibre	Heavy metal salt as catalyst.
2.	Sizing	Pentachlorophenol as antimildew agennt.
3.	Desizing	Not much.
4.	Scouring	(i) Emulsifying agents like nonyl phenyl ethoxylates. (ii) Trichlorobenzene, 1,2 dichloroethane, chloroform as scouring assistant etc.
5.	Bleaching	Hypochlorite (Cl-bleaching).
6.	Dyeing & Printing	(i) Azo dyes containing aromatic amine. (ii) Formaldehyde dye fixing agent for reactive dyeing for viscose/blendds fabrics. (iii) Dyes containing heavy metals such as Arsenic, lead, Cadmimum. Mererery, Nickel. Copper, Chromium, Cobalt and Zinc. (iv) Formaldehyde as a mordant. (v) Oxygen carriers like Vandaium Chloride. Copperchloride. (vi) Formaldehyde fixer/binder for pigments printing of viscose & blends.
7.	Finishing	(i) Formaldehyde as a crosslinker (ii) Reactive softner.

Contd...

Contd... <u>Annexure-III</u>

S.No.	TEXTILE PROCESS	TOXIC SUBSTACNE USED
8.	Speciality finishing	
	Flame Retardant	Tri (2,3 di bromopropyl phosphate), Tri (aziridinyl) phosphinnoxide, Triphenyl polychrorinated biphenyl etc. Chorinated paraffin.
	Water Repellent finish	Zirconium type pyridinum compounds, melaminne - amine compounds, melamine - hydrophobe condennsates.
	Rot proofing	Metal fluorides, DDT, Heavy metal containing other anti-bacteriocides materials.
9.	Garment Manufactures	Stain removers containing chlorinated products.
10.	Packaging	Wooden boxes treated with insecticides.

ANNEXURE-IV

Some of suggested alternatives in the textile processing

1.	Cotton Growing	Use of safe and permissible pesticide like neem, paramethin, cypermethin.
2.	Desizing	Use of amylase enzyme.
3.	Scouring	Use of lipase enzyme (Still in the developing stage).
4.	Dyeing and Printing	i) Reactive, vat, basic natural dyes and dyes absolutely free from hazardous amines (accordidng to the CI number).
		ii) Use of synthetic thickener in place of kerosene for pigment printing.
5.	Finishing	i) Polycarboxylic acid.
		ii) Use of cellulase enzyme.

Contd..

ANNEXURE-V

COMMERCIALLY AVAILABLE ECO-STANDARD TEXTILE CHEMICALS

Function	Name of Chemicals	Name of Company
1. Finishing Agent Formaldehyde (HCHO) free	1. Virkler Comp.	Vircosoft lube 479
	2. Natrium NFO and Natri CRA for Cotton and Polyester/ Cotton blend.	Saraf Chemicals Pvt. Ltd., Mumbai.
	3. Dicrylan BS-RN (HCHO free) Prepolymerised long chain macro moleculars based on non-ionic urethane for cellulosics	Cibar Corporation
	4. ECCO Re2 U-2 (Good crease wash and wear resistant)	Eastern Colour & Chemical Company
2. Levelling Agent	ECCO leveller NH-2	Eastern Colour & Chemical Company
3. Softener/ Lubricant	1. Softonse-250	Dexter Chemical Corporation
	2. Cerranine SK	Sandoz
	3. Bio-degradable quarternery based softener	Henkel Corporation
	4. Reidsville, NC	Boehme Filatex Inc (Silicone Softener)
4. Dispersing Agent	1. Glucopons (Alkyl Poly glucoside, non-ionic)	Hankel Corporation
	2. Vircowet NSL	Virkler Company
5. Crosslinking Agent	1. Fixapret NF Catalyst NB-202	BASF Corporation
	2. Pretavyl 9240	Dr. Bohme Chem. Fabric GmbH & Co.

Contd..

Contd... <u>Annexure-V</u>

Function	Name of Chemicals	Name of Company
6. Carrier	1. Procar ENV	Dr. Th:Bohme Chem. Fabric GmbH & Co.
	2. Polydyol H2-V	Eastern Colour Chem. Corpn.
7. Scouring Agent	1. Raycalube ACA	ICI Rayca
	2. Aklon 25	Eastern Colour Chem. Corpn.
8. Antifungal	GIVGARD DXN	Givaudan-Roure
9. Detergent	Jerposol Ultra	Eco Lab, Inc.
10. Binder	Rohamere FF	Rohm Tech.
11. Solvent Cleaner	1. Cleaner A.K.	Eastern Colours
	2. Solvent Cleaner 9305 (Biodegradable)	- do -
12. Dye Fixative	Ecofix EN-33	- do -

Parameters of Wastewater Generated by Synthetic Fibre Industry

Parameter	Nylon	Polyester
Temperature, °C	30	32
pH	7.25	8.55
Total suspended solids, mg/l[a]	1,388	1,736
Total dissolved solids, mg/l[b]	1,600	1,542
BOD, 5 days, 20°C, mg/l[c] (BOD_5)	619	580
Volatile solids, mg/l	384	632
COD, mg/l[d]	1,459	1,680
Alkalinity (as $CaCO_3$), mg/l	350	730

a. They may create problem during removal by filtration or sedimentation, if present in colloidal form.

b. TDS is the total soluble inorganics. High TDS cause scale formation in boiler, piping etc.

c. Biological oxygen demand (BOD) is a measure of total amount of micro-organism present in wastewater. It is expressed as the amount of oxygen (mg/l water) required to oxidise (eliminate) all the micro-organism at the specified conditions.

d. Chemical oxygen demand (COD) is the amount of oxygen (mg/l) necessary to completely oxidise all organic matters present in water. This includes micro-organisms, oil and soluble organic matters (e.g. oligomers, solvent, spin finish etc.).

Contd...

ANNEXURE-VII

Relevant Standards for Liquid Effluent IS:2490 (Part I) - 1981

Sl. No.	Effluent Characteristics	Discharged on land for irrigation	Discharged in public sewers	Discharged into inland surface water	Maharashtra Board Disposal in saline water
1	TSS, mg/l	200	600	100	100
2	TDS, mg/l	2,100	2,100	2,100	-
3	Temperature, °C		45	40	-
4	pH	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
5	BOD, mg/l	100	350	30	100
6	COD, mg/l	-	-	250	250
7	Oils & Grease, mg/l	10	20	10	-
8	Amononiacal (as N), mg/l	-	50	50	50
9	Sulfates (as SO_4), mg/l	1000	1000	1000	5
10	Phosphates (as P), mg/l	-	-	5	-
11	Sulphides(as S), mg/l	-	-	2.0	-
12	Fluorides(as F), mg/l	-	15	2.0	10
13	Chlorides(as Cl), mg/l	600	1000	1000	-
14	Cyanides (as CN) mg/l	0.2	2.0	0.2	-
15	Lead (as Pb), mg/l	-	1.0	0.10	-
16	Selenium (as Se), mg/l	-	0.05	0.05	-
17	Zinc (as Zn), mg/l	-	15	5.0	-
18	Copper (as Cu) mg/l	-	3.0	3.0	-
19	Nickle (as Ni) mg/l	-	3.0	3.0	-
20	Cadmium (as Cd) mg/l	-	1.0	2.0	-
21	Chromium hexavalent (as Cr^{+6})mg/l	-	2	0.1	-

Contd. ANNEXURE VII

Relevant Standards for Liquid Effluent IS:2490 (Part I) - 1981

Sl. No.	Effluent Characteristics	Discharged			Maharashtra Board
		on land for irrigation	in public sewers	into inland surface water	Disposal in saline water
22	Mercury (as Hg), mg/l	-	0.01	0.01	-
23	Arsenic (as As), mg/l	0.20	0.20	0.20	-
24	Sodium (as Na), %	60*	60*	-	-
25	Phenolic compounds (as C_6H_5OH), mg/l	-	5	1.0	-
26	Residual chlorine (as Cl), mg/l	-	-	1.0	-
27	Free carbon dioxide (as CO_2)	-	-	-	90

* Waived in 3rd revision (1991)

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